E. J. Warwick

U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

ANIMAL HUSBANDRY RESEARCH DIVISION

and

COOPERATING WESTERN STATES

W-1 - IMPROVEMENT OF BEEF CATTLE THROUGH THE APPLICATION OF BREEDING METHODS

1961 Annual Report of W-1

and

Report of

Annual Meeting of Technical Committee

Pullman, Washington

July 19-20, 1961

This report is intended for the use of administrative leaders and workers and is NOT for general publication.

Animal Husbandry Research Division
Beef Cattle Breeding Research
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ANNUAL MEETING
W-1 Technical Committee
Washington State University
Pullman, Washington
July 19 - 20, 1961

N. M. Kieffer, Acting Chairman

Project Leaders Present

Arizona	O. F. Pahnish
California	W. C. Rollins
Colorado	H. H. Stonaker
Hawaii	E. H. Cobb
Idaho	R. E. Christian
Montana	F. S. Willson
Nevada	C. M. Bailey
New Mexico	L. A. Holland
Oregon	Ralph Bogart
Utah	J. A. Bennett
Washington	C. C. O'Mary
Wyoming	P. O. Stratton
U. S. Range Livestock Experiment Station	N. M. Kieffer*
Regional Administrative Adviser	S. S. Wheeler
Western Regional Coordinator's Office	J. S. Brinks*
Agricultural Research Service	
Beef Cattle Research Branch, AHRD	E. J. Warwick
State Experiment Stations Division	M. J. Burris

*Representing J. R. Quesenberry and R. T. Clark

Dr. Kieffer, Acting Chairman for Mr. Quesenberry, who was unable to attend, called the meeting to order at 1:30 P.M., July 19. He expressed appreciation of the fact that Dr. O'Mary and the administration of Washington State University had issued an invitation to hold the meeting at Pullman.

Dr. Wheeler served as chairman for the afternoon session.

Dr. Louis Madsen, Director of the Institute of Animal Science, Washington State University, welcomed the group to Washington State.

REGIONAL RESEARCH: A REVIEW OF THIS METHOD OF CONDUCTING RESEARCH

Dr. L. W. Rasmussen, Assistant Director of Stations
Washington State University

In some respects, and in the minds of some of us, regional research is a new concept and a new program. However, in an informal way, cooperative research, which may be called regional research, has been conducted for many, many years. Cooperation has existed among agricultural experiment stations and between stations and the U. S. Department of Agriculture. In some cases, there was a fairly well planned cooperative attack on a problem, while in others the cooperation consisted primarily of an exchange of information, which, in effect, constitutes a certain amount of cooperative regional effort.

The present day more formal regional research program was started when Public Law 733 was passed by the 79th Congress and signed by the President on August 8, 1946. This law grew out of the efforts of a group of selected experiment station directors constituting a special legislative committee of the Experiment Station's Committee on Policy (ESCOP).

Now, after 15 years, it is probably a good time to make an appraisal of this specific program of regional research. For my discussion of the program here with you, I shall draw heavily on two recent appraisals--one by Dr. R. E. Huffman, Director of the Montana Agricultural Experiment Station, and the other more comprehensive study by Dr. M. A. Farrell, Director of the Pennsylvania Agricultural Experiment Station. Dr. Farrell made his study at the request of the State Experiment Stations Division and the Agricultural Experiment Station Directors.

I personally have been associated in regional research since its early days, first as Chairman of the Technical Committee for W-11 aimed at weed research, and in recent years as Administrative Advisor for several projects. Currently, I am a member and Chairman of the Regional Research Committee--a committee of the Western Region Association of Experiment Station Directors.

Review of Original Objectives and Philosophy

In a review of the circumstances leading up to the establishment of Regional Research, Dr. Farrell cites a communication with one of the members of the original special committee, Dr. Baver. Dr. Baver pointed out that there were two circumstances which suggested the need for a formal regional research program. There was, at that time, and I might say, still is, considerable concern over possible duplication of effort among the various experiment stations. Members of Congressional Appropriation Committees repeatedly asked about duplication of effort; and similar projects in different states had to be defended in one way or another. Therefore, there was a need to coordinate and perhaps cooperate in order

to avoid needless duplication and make best use of the effort and funds expended. Secondly, Dr. Baver indicated that he felt there were certain specialized problems which could be more efficiently worked on and perhaps solved if the talents and facilities of more than one station were brought to bear on the problem. Furthermore, some states have special facilities and special talents which make them a logical center to do a job for the region. Regional research was thus conceived to meet these problems and take advantage of prevailing situation.

A description of regional research appears essentially unchanged from the original in the Amended Hatch Act of 1955, Section 3(c)3, as follows:

> "Not more than 25 per centum shall be allotted to the states for cooperative research in which two or more state agricultural experiment stations are cooperating to solve problems that concern the agriculture of more than one state. The funds available for such purposes, together with funds available pursuant to subsection (b) hereof for like purpose shall be designated as the 'Regional Research Fund, State Agricultural Experiment Stations', and shall be used only for such cooperative regional projects as are recommended by a committee of nine persons elected by and representing the directors of the State Agricultural Experiment Stations, and approved by the Secretary of Agriculture. The necessary travel expenses of the Committee of Nine persons in performance of their duties may be paid from the fund established by this paragraph."

Dr. Farrell in his report summarizes the objectives of regional research with the statement, "The intent and objectives of regional research then, as determined from the legislation itself and testimony given at the hearings, may be summarized as follows:

1. To stimulate and facilitate interstate cooperation on research of a regional and national character, both between agricultural experiment stations and with the U. S. Department of Agriculture.

2. To plan and coordinate research so as to avoid unnecessary duplication in research effort.

3. To organize regional technical committees consisting of state and federal representatives that will plan and coordinate work on regional problems."

The extent to which the objectives of regional research are accomplished depends to a considerable extent upon the philosophy of regional research as held by the various people who become involved in the program. Dr. Farrell's survey brought out that there was a wide range in the philosophy held by many individuals. He indicates there was considerable disparity of opinion. On this subject, I again quote from Dr. Farrell

as follows: "While the words 'Regional Research' themselves should suffice, they do not--there is need to amplify this for newcomers in this Regional program, both to the Directors and new Technical Committee representatives. As stated by one director, 'We constantly need reorientation, redefinition, and reaffirmation of faith'. Can we agree that Regional Research is as another director put it, 'an effort for the region?'" Dr. Farrell continues, "There is a need to keep paramount in all our thinking, planning, and funding that an effort will be made to solve problems for the region. The emphasis at all times is on a regional concept and not on an individual or state concept. The funds are earmarked for a regional effort and are not to be considered state funds in the sense that other Hatch Funds or State Funds are so considered."

In view of these objectives and philosophies, it appears we should give more attention in the planning and persecution of Regional Research to the definition of the problem needing solution. Once the problem is defined then it can be determined the locations and the personnel which can best contribute to the accomplishment of objectives for the solution of the problem. The acceptance and application of these over-all objectives and philosophy are very definitely difficult. Our past operational practices have imposed upon technical committee members very difficult decisions and have resulted in certain problems which should be solved. The solution of these side problems now is being given considerable attention by directors and the Committee of Nine. We can hope that some relief will be forthcoming.

Accomplishments

Although there have been some difficulties, we must all admit, and I am sure we can admit truthfully, that Regional Research has made some very worthwhile contributions. You participants in Regional Project W-1 dealing with cattle breeding I am sure have benefitted by your association one with the other through the years. The exchange of information has fulfilled one of the original objectives of Regional Research. The cooperative planning undoubtedly has permitted you to complement each other's work and utilize methods and techniques more readily than had each of you been left by yourself to work out methods and techniques.

Another Regional Project, WM-21, dealing with livestock information, provided the background data and methodology which led to the publication and distribution of information on livestock marketing. This has been widely accepted and acclaimed for its service to livestock producers and people serving those producers.

An interregional project, IRM-1, dealing with national policies for agriculture has provided background information vital to the development of agricultural policy. This is a current vital issue, and I am sure we all will agree we need more factual information upon which to base the formulation of the future agricultural policy.

Time permitting, I am sure we can run through the long list of regional and interregional projects, citing some notable accomplishment from each. Furthermore, I am sure we would find these accomplishments have come at an earlier date or have been more widely accepted by virtue of the fact that coordinated and cooperative effort went into the research that provided the information.

No program is so well planned and so efficient, however, that it does not need continual criticism and occasional reorientation. Therefore, it is entirely appropriate that we should have this comprehensive study provided by Dr. Farrell. Rather than dwelling at length on the accomplishments and glorifying these in our minds, let's devote more attention to the future of the program.

Problems of Operation

One of the serious problems in the conduct of regional research centers around the committees made up of the research workers which the law stipulates should be brought together. Perhaps the role and scope of operation of these committees has not been adequately spelled out, and we have relied upon the committees to the point of burdening them with administrative details beyond their proper area of operation. In Director Huffman's appraisal of regional research he states, "Regional research introduces at one stage of the organizational structure administration by committee." He points out that planning and coordination of subject matter aspects by a committee is desirable, but certain other tasks should not be saddled onto the committee. Further along he states, "The regional research technical committee member is asked to assume a strictly administrative function and pass judgment on the research proposed by his colleagues on the committee as well as his own proposal. I say it is a strictly administrative function because he is asked to do so not only in terms of rating the proposed research as to quality, importance, and priority, but to recommend allocations of funds to the different phases of the research program. The individual research worker is given this responsibility and asked to make decisions without full information as to how his own research efforts fit into the research program or the budget of his department or his experiment station."

Director Farrell concludes that the regional association of directors should "take more concern along with the committee of nine in crystallizing significant regional programs; the provision of expensive research tools for the region; and the approval of budgets." In other words, a definite effort should be made to separate the planning, coordination, and conduct of the research on one hand from the evaluation of problems to be worked on, facilities, and funds needed to do the work on the other, the former being the logical responsibility of the technical committee and the latter the responsibility of the directors and the Committee of Nine. We do not have an immediate solution for these but I think it is safe to say we can expect it in the future in view of the current appraisals and request for redefinition of regional research.

A major problem which faces all those concerned with regional research in one way or another is that of defining and crystallizing regional problems. As previously stated, much of this falls within the jurisdiction of the directors, but when it comes time to prepare the project proposal, then the prospective members of the technical committee must wrestle with and resolve the matter of the problem to be worked on. I have noted frequently, and I know others have noted, too, that many proposed regional projects are developed in such a way as to encompass any and all related proposals coming from each individual state. In other words, the regional project is a collection of related state projects rather than a coordinated and planned attack aimed at the solution of a regional problem.

Dr. Bruce Beecher of State Experiment Stations Division made a study of all regional projects and concluded that around one-third of the western regional projects were of the type centered around a regional problem constituting closely coordinated, well-planned attacks. The other two-thirds were what he called contributing projects centered; that is, they were made up of closely related state projects all drawn together in what was supposed to be a regional project. Many of these were of the type often called "umbrella" or "mother hubbard" projects.

It appears, therefore, that once the association of directors is convinced there is a regional problem requiring and justifying a regional attack for its solution, then the technical committee with the aid and guidance of the administrative adviser should develop a project around that problem aiming at its most direct and efficient solution, utilizing the personnel and facilities available within the region.

Another problem of considerable importance is that of funds and the competition for funds. As stated earlier, we have too often relied upon the technical committee to determine how much money should go to each state and thereby we have placed administrative decisions upon the committee members when they were not really in a position to make judgment with all of the factors before them. There has been, and perhaps still is, a feeling among some that here is a source of money and we should each get our share of it. In the planning of a new research proposal it is only natural for a technical committee member to feel "left out" if he comes home from the planning session without being included in the final program with a promise for a reasonable operating fund.

This competition for funds in the western region is very severe because of pressure upon the western directors to approve additional projects hoping that funds would increase and permit their full activation. In fiscal year 1957 we had 52 regional projects while in the fiscal year just ended we had 62 regional projects. With this increase in number of projects the mean sum of money per project was reduced from $24,785 in 1957 to $23,789 in fiscal '61. At this same time the cost of doing research has, as we all know, been increasing. According to National Science Foundation figures over that period of five years, the cost has gone up around 31 percent.

Therefore, in order to finance the 62 projects at a level equivalent to the 52 projects we had in fiscal '57, we would need in the western region an additional sum of $539,666. This is a trend I sincerely believe should be changed, even though it means reducing the number of regional projects to provide more adequate financing for those we keep activated. I am sure you in W-1 feel the pressure for adequate funds to do the work you visualize as needing to be done. At the same time, I would charge you with the responsibility of reappraising the whole problem before you to determine whether you are attempting to do too much at once and spread your efforts too thinly. Each of you will need the help of your individual director as well as your administrative adviser, but I believe it would be worthwhile to determine very specifically what is the principal problem most in need of regional effort for solution. It should then be determined whether this can best be accomplished by a few states or by all 12 states.

Future Trends

My crystal ball is not sufficiently effective to tell you just what the future trends for regional research should or will be. I am convinced of one thing, however, and that is we will continue to have a program of regional research and I think this is justifiable and good. I believe sincerely the benefits and accomplishments have far offset the difficulties and shortcomings. I have stated previously the directors and the Committee of Nine now have before them the report of the study by Director Farrell. This study provides a very good appraisal and makes some suggestions for what appears to be some worthwhile reorientations. Just what they will be and how far they will go are yet to be determined by the directors and the Committee of Nine. Within the next year we will probably know more about the future directions and have crystallized revised procedures and clear definitions of responsibilities for everyone from the Committee of Nine to the Technical Committee member.

Summary

I have outlined briefly the circumstances and thinking which led to the establishment of a specific program of regional research. Also, I reviewed some of the objectives and philosophies of the program suggesting some clarification. I mentioned only briefly some accomplishments, but suggested many could be cited. Then, I dealt with some problems of operation and the need for some clarification of responsibility of those involved in various aspects of the program. Finally, I concluded the program is basically good and that effort is being made to remove some of the shortcomings.

The group reconvened at 7:00 P.M. Dr. M. E. Ensminger introduced the speaker.

ATOMIC ENERGY AND ANIMAL AGRICULTURE

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General Electric Company, Richland, Washington

More than perhaps any other product of our civilization, atomic energy has two distinctly different sides, one good and the other bad, bad as far as public opinion is concerned, whether that reputation is deserved or not. Since Hanford, one of the world's major atomic energy centers, is only 140 miles away, I would like to discuss these two facets of atomic energy with particular reference to animal agriculture. In so doing, I shall describe a little of what we at Hanford are doing about one of them.

The great good atomic energy is doing is the result of a methodological break-through. The availability of artificial radioactive elements in large amounts made possible profound effects on our technology. Much of this is due to the incredibly few radioactive atoms that are required for detection by modern instrumentation. In fact, radioactive elements can be detected one thousand to one million times below levels at which they are believed to be perfectly safe. This property makes radioelements useful as ultra-sensitive tracers of ordinary substances that comprise living material. The method of detection depends upon atomic disintegration whereby an element lets go a subatomic particle from its nucleus which can be detected electronically. Such radioactive disintegrations are not uniquely the consequence of artificial radioactivity. Every second, in each one of us, more than 400,000 atoms disintegrate. This is not because of fallout nor of Hanford. This phenomenon has been going on since the beginning of time because of the presence of radioactive elements throughout nature. But with the advent of controlled atomic energy has come the availability of nearly 900 different radioisotopes.

The variety of ways radioactive atoms have been used in agriculture and its products is a fascinating story. Subatomic particles emitted by radioactive elements are stopped with increasing efficiency by increasing thickness of materials interposed between the source of the particles and the detector. This property is utilized in the thickness gauge. An adaptation of it makes better noodle soup by controlling the ratio of noodles to meat and broth. You may have noticed that you don't need to pound the catsup bottle any more. This is partly because the consistency of the paste is controlled with the help of the radioisotope thickness gauge. Similarly, beer, detergents, and other liquids now are controlled by radioactive gauges. Even the thickness of soda crackers and the fat content of baby foods can be kept within limits with the help of a radioactive gauge.

It is estimated that American agriculture pays nearly a four-billion-dollar annual loss because of insects. This is due to insect attacks on crops and their torment of stock which causes the latter to fail to gain weight and yield normal quantities of milk. This is on top of their other nuisance values--as transmitters of disease to man and as destroyers of clothing and home furnishings.

Radiation can be used to kill insects--about 100 to 1,000 times more is required than that which will kill humans. Studies are being made of the practicality of using fission products--a by-product of the manufacture of plutonium and atomic energy--as a radiation source for destroying insects by irradiating stored grains, processed and packaged foods, clothing, and wool products. The Fission Products Laboratory of the University of Michigan has planned an apparatus for installation in a railroad box car capable of processing 6,500 bushels of material a day at an estimated cost of 6 to 8 cents a bushel.

Radiation can kill bacteria, can stop potatoes and onions from sprouting, and can stop the reproduction and growth of weevils in wheat and trichinae in pork. It can be used for luminescence also, and for sterilizing catgut sutures for surgery. Unlike heat sterilization, elasticity is retained. Food processing by radiation has gained wide attention, and it is likely that radiation will be used for special purposes such as in insect control and also in extending the shelf life of certain foods, rather than as a competitor to canned, frozen, or dehydrated foods.

One of the most interesting uses of ionizing radiation is found in the story of the screwworm. This worm lays its eggs in cuts and scratches in cattle. The resulting grubs cause debilitating sores that lead to poor hides for leather, and weight loss and possible death of the animal. In the past, it is conservatively estimated that the screwworm has caused a twenty-million-dollar annual loss in the Southeast and about a three-million-dollar annual loss in the Southwest. By the use of ionizing radiation the screwworm now has been irradicated in the Southeast. This is how it was done. Nearly three billion screwworm male flies were grown, irradiated sufficiently to make them sterile, and then turned loose by airplane over a 75,000-square-mile area. Upon their mating with female flies, sterile eggs resulted. Since the female conceives only once, this process, continued for several generations, reduced the insect population to zero.

The cotton boll weevil causes a quarter-billion-dollar annual loss, and the corn borer a four-million-dollar loss each year. Research into methods for their irradication may yield handsome profits, and it is possible that these same methods can be made applicable to mosquitoes and the tsetse fly in North Africa.

At Hanford, with the cooperation of Dr. Ensminger and other members of the Washington State University staff, we are attempting to find a relationship between meat production in swine and metabolic rate as evidenced by thyroidal uptake of radioactive iodine.

The other side of the coin concerns the hazards of atomic energy. A phenomenon of our time is the concern of the public to fallout. Never before has a potentially hazardous material been so thoroughly measured, talked about, and exaggerated, and I doubt very much if this ever will happen again for any other material.

Fallout is the name given to fission products caused by atomic fission in weapons tests. Usually, they are attached to dust particles and gradually settle to earth from the atmosphere. During the first tests of the practicality of nuclear explosions, radioactive dust fell onto nearby livestock. Radiation burns that resulted were followed by discoloration of hair. This was due mostly to beta emitters. Beta particles have low penetration power and hence expend most of their energy in the skin. At Hanford, we are doing some controlled studies on response of pig skin to beta irradiation. White pigs are suited nicely to studies of this type because of the similarity of their skin structure to that of humans.

Other organs can be affected if the radiation can get to them. If the source is external, gamma emitters will do it. Another way is that the radioactive substance may be absorbed into the body, as by inhaling, swallowing, or absorption through the skin. Depending on the element, it may be selectively deposited in certain organs, as bone for Sr^{90}. Bone is presumed to have median sensitivity and is one of the two organs of great concern to people who worry about fallout. Bone marrow is where leukocytes are manufactured, and leukemia or "cancer of the blood" is an over-supply of leukocytes.

From work with experimental animals we know that, say, 1 mc. of Sr^{90} per gram of bone will cause one out of ten animals to develop leukemia. From this it is assumed that one one-thousandth of a mc. would cause one in ten thousand animals to develop the disease. If the Sr^{90} in world-wide fallout results in a dose of one one-hundredth of that, it is presumed that one in a million humans would get leukemia. One in a million is pretty small, but on a world-wide basis, two thousand people would get leukemia. This is an example of the "numbers racket" in modern biological science.

A similar situation holds for radiation of germinal cells. Mutation is assumed to increase with radiation dosage in a linear fashion. Using an argument similar to the previous one, it can be argued that fallout should cause an increase of misfits in the coming generation.

But what it means in the actual case leads to different conclusions. Radiation that man's germinal cells receive comes from any of several sources--medical uses of x-ray, cosmic rays, and ubiquitous natural radioactive elements. Of it, only a maximum of one percent comes from fallout.

This leads one to question whether the near-hysterical reactions to radiation is deserved, or whether there is something wrong with our perspective. If we compare the dollars spent on investigating atomic energy hazards with that spent on all other man-made hazards, we find a large fraction of the total dollars is spent on atomic energy. The publicity given to atomic energy hazards far overwhelms that given others. But

so far as real hazard is concerned, from comparison of industrial safety records, the presence of man-made radiation, and an inherent feeling of one engaged in hazard-control research, atomic energy is a minor contributor to man-made hazards, is nearly insignificant, but is far from negligible.

The biology program at Hanford occupies about 90 people and is concerned with a variety of research projects designed to learn more about the biological hazards of atomic energy and its control as well as fundamental aspects of radiation biology. Part of the program is concerned directly with atomic energy hazards and agriculture. In fact, some of our first research, started in 1948, went along those lines. Because radioiodine a fission product and a by-product of plutonium manufacture was released to the atmosphere and settled on grazing lands, we sought to find what levels could be safely fed sheep. In getting this experiment started, Dr. Ensminger became our distinguished consultant. This became the first large animal experiment done to find a permissible limit for a radioisotope.

Although this experiment continued for many years, we have turned to other work with large animals. We now are trying to determine the effects of feeding pigs daily doses of Sr^{90}. A miniature breed is being used whose internal organs and diet resemble those of man. We like the animal so much for experimental purposes that we are trying to develop a white one for skin studies also. In the meantime, we are using the smaller pig for special metabolic studies and the large animal for extending the I^{131} work done with sheep to pigs.

How much fallout gets into animals from direct contamination of vegetation as compared to uptake from contaminated soil is unknown, but we are measuring the uptake from soils into plants and the factors that affect uptake.

The most adventuresome of our activities in fallout studies is in support of Operation Chariot. Each year we send a team of ecologists to the site in Arctic Alaska where atomic explosions may be used to form a harbor at a considerable savings over conventional methods. Their purpose is to measure radioactivity and natural populations before and after the harbor is formed.

One of the team's findings is that lichens contain relatively high concentrations of fallout radioelements. Since this is a favorite food of caribou, the caribou are relatively high in radionuclides, and since Eskimos eat caribou, concern has been expressed for the Eskimos should the project be culminated.

THE DESIGN OF EXPERIMENTS WITH PARTICULAR REFERENCE TO CROSSBREEDING RESEARCH

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Agricultural Research Service, U. S. Department of Agriculture

The principles involved in the design of experiments are discussed in many textbooks and it is not the purpose of this paper to review these basic principles. However, one important point in the design of any experiment, which fortunately has received more attention in recent years, is the careful study of the method of analysis prior to the conductance of the experiment. In the field of animal breeding, where the problem of unequal or disproportionate subclass numbers is so frequently encountered, a thorough consideration of the method of analysis seems particularly vital. Many problems exist with this type of data that do not exist with balanced designs and must be taken into account if reasonable answers to the questions posed are to be expected.

The most commonly used method of analyzing data with disproportionate subclass numbers is the method of fitting constants. The increasing knowledge of the method of fitting constants in least-squares analyses in the past few years has been of great help, particularly to workers in the field of animal breeding. However, there is still a great lack of textbooks and publications dealing with this type of analysis. As a result, some points of importance have been ignored in recent analyses and some short-cut methods have not been utilized.

Some publications and recent analyses have implied that the method of fitting constants applies only to the case where interaction is negligible. Hence, many analyses have been made by fitting constants for main effects only and ignoring the question of whether interactions do exist. It should be pointed out that the method of fitting constants applies to both situations--interaction present and interaction negligible. When dealing with equal subclass numbers, the presence or absence of interaction does not affect the computation of the sums of squares for the main effects. However, when dealing with disproportionate subclass numbers, the computation of the sums of squares for the main effects differs depending on whether the interaction is considered negligible or of importance.

As pointed out by Harvey (3), when interaction effects are found to be significant, estimates of main effects and the corresponding sums of squares are biased if these interaction effects are ignored. An example in the publication referred to above shows the analysis of a two-way classification with disproportionate subclass numbers where interaction has been ignored and also where it has been included in the model. Under the assumption of no interaction, the analysis of variance was:

Source of variation	D.F.	Sums of squares	Mean square	F
Sires (S)	2	15.6786	7.8393	1.95 n.s.
Rations (R)	1	9.7036	9.7036	2.41 n.s.
Error	14	56.2964	4.0212	

with the following constants for the mean and main effects:

$\hat{\mu}$ = 4.8876 $\quad\quad$ $\hat{f}_1$ = -.8090

$\hat{s}_1$ = -.8876 $\quad\quad$ $\hat{f}_2$ = .8090

$\hat{s}_2$ = 1.3146

$\hat{s}_3$ = -.4270

However, a test of significance indicated that the interaction effect was significant, so a second analysis was made including the interaction in the model. The results of this analysis were:

Source of variation	D.F.	Sums of squares	Mean square	F
Sires (S)	2	21.0015	10.5008	4.83*
Rations (R)	1	3.5916	3.5916	1.65 n.s.
S × R	2	30.2245	15.1122	6.96*
Error	12	26.0652	2.1721	

with the following constants for the mean and main effects:

$\hat{\mu}$ = 4.8889 $\quad$ $\hat{s}_3$ = -.6889 $\quad$ $\hat{f}_1$ = -.5222

$\hat{s}_1$ = -.8889 $\quad\quad\quad\quad$ $\hat{f}_2$ = .5222

$\hat{s}_2$ = 1.5778

In this example both sires and rations were considered as fixed effects. The difference between the two analyses is quite striking and points out the importance of the consideration of the interaction effect. As a further example of this point, data are taken from an analysis made recently by Biometrical Services. An analysis of data from a two-way classification ignoring interaction yielded the following results:

Source of variation	D.F.	Sums of squares	Mean square	
A effects	7	48522	6932	
B effects	2	72790	36395	

A test of significance showed that the interaction effect was significant so a second analysis of these data was made including the interaction, with the following results:

Source of variation	D.F.	Sums of squares	Mean square
A effects	7	49414	7059
B effects	2	34743	17372
A × B interaction	14	27502	1964

While the sum of squares for the A effects has not been altered greatly by the inclusion of interaction in the model, the sum of squares for B effects has been more than halved and a sizeable sum of squares now appears for interaction.

In many animal breeding experiments, the problem of adjusting records for inbreeding is encountered. For example, in testing differences in performance among inbred lines, the inbreeding is frequently included in the model to take into account this source of variation. However, most analyses of this nature that have been made assume that inbreeding affects each line equally. Thus, all lines are adjusted from a pooled regression of performance on inbreeding. Since it is well known that all lines do not respond to inbreeding to the same degree, this pooled regression could lead to erroneous adjustments and results in biased sums of squares. This is actually a type of an interaction, that of a continuous variable with a discrete variable. This interaction of inbreeding by line could be tested by fitting the regressions of performance on inbreeding on an individual breed basis. Tests of the significance of differences among these regressions would then yield a basis for deciding whether a pooled regression is satisfactory or whether individual regressions should be retained in the model.

One of the difficulties that has caused the neglect of testing interactions has been the large number of equations that are usually involved in the analysis of animal breeding data. Although no easy answer is available for all cases, the value of absorption should be pointed out. Frequently, by the use of this procedure, matrices can be reduced to a size where the desired results can be obtained. While absorption is frequently used by combining the mean with a main effect, it should be noted that more than one effect can be absorbed to considerable advantage. For example, in an analysis using the following mathematical model:

$$y_{ijkl} = \mu + a_i + b_j + (ab)_{ij} + c_k + (ac)_{ik} + (bc)_{jk} + (abc)_{ijk} + e_{ijkl}$$

the subclasses $\mu + a_i + b_i + (ab)_{ij}$ could be absorbed into the remaining equations, making tests of significance possible among these remaining effects. As pointed out by Henderson (3), one should start the testing with those effects least likely to exist and delete from the model those effects found to be negligible.

It may be possible in some experiments to equalize the numbers in certain of the classifications, although not in all. When this is possible, the least-squares equations result in patterned matrices which reduce the labor of the analysis by a considerable amount.

When all subclasses are filled and tests of significance have shown that the interaction components should be included in the model, the weighted squares of means method of analysis may be utilized. While this method does not yield the sums of squares for interactions, it does give the constants for the main effects and interactions as well as the least-squares sums of squares for main effects. The method of analysis of two-way and three-way classifications by weighted squares of means is given by Bowles (1). By relatively simple transformation matrices, the weights obtained in this type of analysis can be used to obtain the inverse elements of the segments that would be computed in a least-squares analysis for each of the main effects. Thus, it is possible to carry out mean separation tests among the least-squares means. When a continuous variable is included in the model, the constants and the sums of squares can be adjusted for the regression. It is possible in some analyses to make use of both the method of fitting constants and the method of weighted squares of means.

While the preceding remarks apply in general to analysis of nonorthogonal data, they are of particular importance in designing a crossbreeding experiment where one gets into more complex models and analyses. The questions to be answered should be stated clearly and the method of analysis studied closely to be certain that the experiment is designed so that answers can be obtained. For example, in conducting a crossbreeding experiment, one would like to estimate the importance of maternal effects, specific and general combining ability effects, and sex-linked effects. However, a study of the analysis shows that estimates of all these effects are not possible unless a minimum number of lines are used. The degrees of freedom available are shown below where p lines are used.

Source of variation	Degrees of freedom
General combining ability	$p-1$
Specific combining ability	$\frac{p(p-3)}{2}$
Sex-linked effects	$\frac{p(p-3)}{2} + 1$
Maternal ability	$p-1$

It can be seen that unless four lines are used in the experiment, estimates of the specific combining ability effects are not possible. If one is interested only in the effects shown above, analysis of the data would use the following model:

$$y_{ijk} = \mu + g_i + g_j + m_j + c_{ij} + r_{ij} + e_{ijk}$$

where y_{ijk} is the k^{th} observation on the progeny from the i^{th} line of sire and the j^{th} line of dam, μ is the over-all mean, $g_i(g_j)$ is the general combining ability effect for the $i^{th}(j^{th})$ line, m_j is the maternal effect for the j^{th} line of dam, c_{ij} is the specific combining ability effect, r_{ij} is the sex-linked effect, and e_{ijk} is the random error. In this type of experiment the interest lies in appraising individual lines or crosses. Generally, there are other sources of variation which would have to be included in the model.

The amount of heterosis is of interest in some studies of linecrossing. An over-all estimate of heterosis can be obtained by including pure lines in the experiment. Inclusion of the pure lines will provide one degree of freedom in a comparison of the purebreds with the crossbreds, and p-1 degrees of freedom for differences among the lines.

As Henderson (1) has pointed out, unless the lines are nearly homozygous, sire differences within lines may be quite large. Apparent line differences may be partially due to accidents of sampling in the selection of the sire or sires used in testing the line. By using more than one sire per line per year in single-cross tests, estimates can be obtained of sire differences and sire by line of dam interaction. Equations for these additional effects would then be included in the model. Since this increases the size of the coefficient matrix considerably, tests of significance become much more difficult, further emphasizing the necessity of a thorough consideration of the analysis when planning the experiment.

One of the recent phases of beef cattle breeding experimentation has been the crossing of different breeds of cattle to determine the best combination of breeds for commercial production in a particular area. In this case, the main interest lies in a ranking of the various crosses and tests among these crosses for the different traits being evaluated. Normally, this would be done over a period of years, and the analysis would take the form of:

$$y_{ijk} = \mu + a_i + g_j + (ag)_{ij} + e_{ijk}$$

where y_{ijk} is the k^{th} observation in the j^{th} breed group in the i^{th} year, μ is the over-all mean, a_i is the effect of the i^{th} year, g_j is the effect of the j^{th} breed group, $(ag)_{ij}$ the interaction between the i^{th} year and the j^{th} breed group, and e_{ijk} the random error. The same data could be analyzed with the purpose of determining the differences among breeds of sires when mated to all breeds of dams, differences among breeds of dams when mated to all breeds of sires, and the interaction between breed of sire and breed of dam.

As the development of lines of cattle progresses in the regional breeding programs, it is likely that crosses among lines from several different breeds will be planned. Data from such experiments will yield information concerning the general combining ability among breeds, maternal ability among breeds, specific combining ability among breeds, general combining ability among lines within breeds, maternal ability among lines within breeds, and specific combining ability of line crosses within breeds.

Another type of crossbreeding design which is of interest is that of crossing inbred males on single-cross females. Data from these crosses furnish information on the general combining ability of lines, the general combining ability for maternal ability in single-cross females, specific combining ability with respect to performance as single-cross dams, and three-way interaction or specific combining ability. The mathematical models for these two types of designs are given by Henderson (1) and will not be repeated here. The analysis of data from these designs is rather complex and will require considerable study.

Whatever the experiment being designed, one is usually concerned with predicting the performance of the lines in repeated sampling. It is important then, particularly in lines with low inbreeding, that care is taken in selecting animals which are as representative of the lines as possible. This has already been alluded to in discussing the advantage of using more than one sire per line per year. Since the experiment is normally conducted over a period of years, producing the crosses from different females in each year will ensure a wider sampling of the line than using the same females to produce the same cross in each year.

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(2) Bowles, R. L.
1950. Accuracy of certain approximate methods in predicting the correct model for experiments with unequal frequencies in the subclasses. From a thesis submitted at Iowa State College, Ames

(3) Harvey, W. R.
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UNIVERSITY OF ARIZONA

I. Station: Arizona Agricultural Experiment Station, Tucson, Arizona

II. Project Title: Breeding and selection of beef cattle for the Southwest

III. Personnel:

Experiment Station:

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Cooperators:

Empire Ranch, Sonoita, Arizona
Arivaca Ranch, Arivaca, Arizona
Apache Indian Agency and Apache Tribe, San Carlos, Arizona

Montana Agricultural Experiment Station, Bozeman, Montana
Wyoming Agricultural Experiment Station, Laramie, Wyoming
U. S. Range Livestock Experiment Station, Miles City, Montana

U. S. Department of Agriculture, Agricultural Research Service:

R. T. Clark, Coordinator

IV. Nature and Extent of Work Done This Year:

Empire and Arivaca Ranches

Data collection on these ranches was terminated with collection of the fall yearling data in September 1960.

Data processing is in progress, with emphasis on analyses of post-weaning data.

A portion of the study of pre-weaning traits was published in abstract form and a manuscript is now in press.

Apache Tribal Herd

Data as described in the project plan have been collected on the 1957, 1958, and 1959 calf crops through 24 months of age, and on the 1960 calf crop through 12 months of age.

Chemical analyses of blood and liver samples were kept current.

Liver biopsies were terminated with the collection of samples at two years of age from the animals born in 1959.

Results of the preliminary studies of some of the blood and liver constituents were published or prepared in manuscript form.

Statistical analyses of the growth data, conformation scores, and condition scores collected on three calf crops (1957-59) were partially completed.

Fourteen sires were used in the 1961 breeding program. These included some of the Miles City and San Carlos bulls previously tested, as well as some of their male progeny selected on the basis of range performance records.

V. Summary of Progress and Conclusions to Date:

Studies of the pre-weaning data from the Empire and Arivaca herds and the vitamin A and carotene values from the Apache Tribal herd were discussed in prior reports. Results of the statistical analyses of the growth data, conformation scores, and condition scores from the Apache Tribal herd are summarized in tables 1 through 4. Results of a preliminary study of serum proteins (Apache Tribal herd) are summarized in tables 5 and 6.

Growth Data and Scores at Weaning

Weaning weight was influenced significantly by year, sex, age of dam class, sire,and weaning age, as might be expected. Contrary to results from the Empire and Arivaca herds, there were no significant sex × year and sex × age-of-dam interactions. Nevertheless, sex differences did increase consistently with increases in mean weaning weight due to year differences and to apparent differences in milk supply attributed to age of dam.

Daily gain from birth to weaning was affected to a statistically significant degree by the variables that affected weaning weight with two exceptions, (1) the sex × year interaction was significant ($P < 0.05$), and (2) differences in weaning age had little effect on average daily gain from birth to weaning time.

The analyses of the conformation and condition scores are not easily interpreted because of unavoidable changes in personnel on the scoring committee. Such changes could have contributed to such things as year variations and to the sex x year interactions. The effects of most variables, however, were quite small and represented negligible fractions of a feeder grade or minor differences in condition.

While the analyses indicate appreciable differences in weaning weights and gains among sire progenies (table 2) the multiple range tests desired for a more detailed evaluation were not completed when this report was prepared. Although conformation scores differed significantly among progeny groups, it should be noted (table 2) that the means were all within the choice feeder grade.

Growth Data and Scores at Fall Yearling Age

Year effects on all weights, gains, and scores were highly significant (table 3). Presumably due to the forage differences in the pastures on which the bulls and heifers were run after weaning, the year constants for weight and gain estimated from the two sets of data are not in agreement (table 4).

Bulls that presumably received the most milk prior to weaning weighed heaviest as fall yearlings and gained fastest from birth to fall yearling age. Heifers showed the same trend but not to a statistically significant degree.

With the exception of daily gain of heifers from weaning to fall yearling age, sire effects on all gains and on fall yearling weights were statistically significant. In some cases, the sires would not be evaluated in the same way on the basis of both bull and heifer progeny. Perhaps multiple range tests will aid in the interpretation of some of the discrepancies noted.

Fall yearling weights were significantly affected by age differences ($P < 0.01$), but none of the daily gains was affected appreciably by the age variable.

Yearling conformation and condition scores differed significantly among years. As in the case of weaning scores, changes in personnel on the scoring committee may have been a contributing factor. Scores were not significantly affected by age of dam, sires, or differences in age at time of scoring.

Relative Amounts of Serum Proteins at Weaning Age

Relative amounts of albumin and the three globulin fractions (alpha, beta, and gamma) in the blood sera of 104 calves at a mean age of 235 days were determined.

The unadjusted means of the various fractions (in percentages), the standard deviations, and the coefficients of variation are summarized in table 5. Beta globulin was the most variable fraction and was followed in descending order of variability by gamma and alpha globulin and albumin. Variation among heifer calves was greater than among bull calves in all cases.

The evaluations of the effects of sex, age of dam, sire, and weaning age of calf on the relative amounts of the serum proteins are summarized in table 6. Heifer calf serum contained a greater relative amount of beta globulin and a lesser relative amount of gamma globulin than did bull calf serum ($P < 0.05$). None of the protein fractions was affected to a statistically significant degree by age of dam. Sire effects on beta globulin were significant ($P < 0.05$); however, the unusual serum values of one heifer contributed to all significant sex and sire differences shown in table 6. Albumin percentage decreased by 0.095 per day ($P < 0.05$) as weaning age increased. While effects of weaning age on the other fractions were statistically nonsignificant, the increases in the relative amounts of beta and gamma globulin (+ 0.045 and + 0.044 per day, respectively) nearly compensated for the reduction in albumin percentage with increase in age.

Table 1.--Variance analyses of weaning data (calves dropped from 1957 through 1959)[1]

Variable	D.F.	Mean squares			
		Weaning weight	Daily gain birth to wean.	Conf. score	Cond. score
Year	2	68,866.5**	1.1965**	48.90**	67.73**
Sex	1	121,810.0**	1.7689**	11.99**	8.14**
Sex x year	2	5,083.5	0.1132*	8.12**	3.74*
Age of dam[2]	2	20,417.5**	.3134**	7.48**	4.79**
Sex x age of dam	2	2,555.0	.0438	1.87	.88
Sires	16	4,523.1**	.0722**	1.88*	1.35
Weaning age	1	325,649.0**	.0212	1.76	3.38*
Error	509	1,988.5	.0352	1.06	.84

[1] Total of 536 calves. ** $P < 0.01$. * $P < 0.05$.
[2] Age of dam classes were: 3, 4, 11 years; 5, 10 years; 6, 7, 8, 9 years.

Table 2.--Estimates of general means and constants from least squares analyses of weaning data

Means and constants	Miles City line	Yrs. sire was represented	N	Weaning weight	Da. gain birth to weaning	Conf. score[a]	Cond. score
General means[b]			536	443	1.60	10.8	10.5
Year:			Constants[c]				
1957			154	-31	-.13	-.2	-.4
1958			197	6	.02	.7	.8
1959			185	25	.11	-.4	-.4
Sex:							
Bull calves			279	16	.06	-.2	-.1
Heifer calves			257	-16	-.06	.2	.1
Sex X year:							
1957, bulls			80	-6	-.03	-.3	-.2
1957, heifers			74	6	.03	.3	.2
1958, bulls			106	2	.01	.1	.1
1958, heifers			91	-2	-.01	-.1	-.1
1959, bulls			93	5	.02	.1	.1
1959, heifers			92	-5	-.02	-.1	-.1
Age of dam:							
Cows (3,4,11 yrs.)			209	-11	-.04	-.2	-.2
Cows (5, 10 yrs.)			117	0	.00	.1	.1
Cows (6,7,8,9 yrs.)			210	10	.04	.1	.1
Sex X age of dam:							
Bulls by cows 3,4,11 yrs.			106	-3	-.02	.1	.1
Heifers by cows 3,4,11 yrs.			103	3	.02	-.1	-.1
Bulls by cows 5,10 yrs.			64	0	.00	-.1	.0
Heifers by cows 5,10 yrs.			53	0	.00	.1	.0
Bulls by cows 6,7,8,9 yrs.			109	4	.01	.0	-.1
Heifers by cows 6,7,8,9 yrs.			101	-4	-.01	.0	.1
Sire:							
1	1	57	21	24	.08	.0	.0
2	1	57-59	63	-6	-.03	-.4	-.5
15	1	59	14	0	-.02	-.2	-.3
3	6	57-59	53	1	.00	.3	.2
4	6	57-59	63	-17	-.05	-.1	-.2
5	9	57-59	64	14	.07	.1	.1
6	9	57-59	52	8	.03	-.1	-.1
16	10	59	12	-4	-.03	.1	-.1
17	10	59	15	-18	-.08	-.5	-.3
7		57	12	18	.08	.9	.8
8		57	7	41	.16	.2	.4
9		57	11	8	.05	.1	.4
10		58	21	-24	-.09	.1	.1
11		58-59	34	-11	-.05	-.1	.0
12		58-59	35	-15	-.05	.0	.1
13		58-59	45	-9	-.03	-.2	-.1
14		59	14	-11	-.06	-.4	-.4
Weaning age			536	1.439	-.0004	.0041	.0046

[a]Based on feeder grades. High, middle, and low choice values are 12, 11, and 10, respectively

[b]Estimates of means at 226 days of age

[c]Constants expressed as deviations from the mean

Table 3.--Variance analyses of fall yearling data (animals dropped from 1957 through 1959)[a]

Variable	D.F.	Mean squares					
		Fall yearling weight	Da. gain birth to yearling	Da. gain wean. to yearling	Da. gain 12 mo. to yearling	Yearling conf. score	Yearling cond. score
			BULLS				
Year	2	89,502.5**	.2495**	.4279**	3.8627**	58.88**	68.74**
Age of dam	2	25,726.5**	.0559**	.0033	.0651	1.70	.59
Sire	16	14,499.6**	.0364**	.0547**	.0909**	1.30	1.02
Yearling age	1	140,090.0**	.0335	.0001	.0373	1.55	.36
Error	197	3,575.0	.0097	.0161	.0305	0.85	0.61
			HEIFERS				
Year	2	46,623.0**	.1213**	.1108**	.2490**	28.07**	49.38**
Age of dam	2	1,196.0	.0022	.0015	.0056	0.22	0.43
Sire	16	6,718.0*	.0182*	.0231	.0483*	0.81	0.58
Yearling age	1	76,845.0**	.0014	.0066	.0009	2.70	1.81
Error	184	3,308.6	.0087	.0146	.0281	0.77	0.55

[a]Total of 219 bulls and 206 heifers.

**P < 0.01

*P < 0.05

Table 4.--Estimates of general means and constants from least squares analyses of fall yearling data

Means and constants	Miles City line	Years sires represented	N		Yearling weight		Da. gain birth to yearling		Da. gain wean. to yearling		Da. gain 12 mos. to yearling	
			Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
General means[a]			219	206	756	749	1.14	1.13	.82	.87	1.31	1.33
					CONSTANTS[b]							
Year of birth:												
1957			60	51	-26	-43	-.04	-.07	-.06	-.05	.12	-.10
1958			88	83	-27	26	-.05	.04	-.10	.05	-.31	.03
1959			71	72	52	17	.09	.03	.05	.00	.18	.07
Age of dam:												
3,4,11 yrs.			80	82	-17	-3	-.03	.00	.00	.00	-.02	-.01
5,10 yrs.			55	45	-2	-2	.00	.00	-.01	.00	-.01	.00
6,7,8,9 yrs.			84	79	20	5	.03	.01	.01	-.01	.03	.01
Sires:												
1	1	57	10	7	120	45	.19	.07	.25	.02	.30	.05
2	1	57-59	26	25	20	-13	.03	-.02	.04	.01	.08	-.01
15	1	59	7	4	-23	44	-.04	.07	-.01	.04	-.05	.00
3	6	57-59	21	25	6	-44	.01	-.07	.00	-.08	-.05	-.10
4	6	57-59	24	20	-31	-13	-.04	-.01	-.04	.01	-.07	.01
5	9	57-59	21	27	21	6	.04	.02	-.01	.01	.07	.02
6	9	57-59	20	17	5	16	.01	.03	.02	.03	.02	.09
16	10	59	4	8	-22	13	-.04	.02	-.07	.06	-.04	.06
17	10	59	7	5	-69	-3	-.10	-.01	-.06	.00	-.12	.02
7		57	8	44	24	8	.04	.01	.01	-.02	.02	.04
8		57	2	2	31	39	.03	.05	-.01	-.02	.03	-.03
9		57	7	2	52	44	.10	.06	.10	.10	.15	.08
10		58	9	7	-47	-21	-.07	-.03	-.08	.01	-.11	-.01
11		58-59	13	16	-67	-43	-.11	-.07	-.16	-.08	-.14	-.13
12		58-59	15	12	-23	-38	-.03	-.06	-.04	-.07	-.09	-.11
13		58-59	19	19	-7	-35	-.01	-.05	-.01	-.04	-.02	-.04
14		59	6	6	11	-4	.01	.00	.05	.03	.03	.07
Yearling age					1.542	1.148	.0008	.0002	-.0001	-.0003	.0008	-.0001

[a] Estimates of means at 590 days of age.
[b] Constants expressed as deviations from the mean.

Table 4.--Estimates of general means and constants from least squares analyses of fall yearling data--Continued

Means and constants	Miles City line	Yrs. sires repre-sented	N		Conf. score[a]		Cond. score	
			Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
General means[b]			219	206	10.2	11.1	10.0	11.0
			CONSTANTS[c]					
Year of birth:								
1957			60	51	.5	.2	.6	.0
1958			88	83	-1.2	-.8	-1.3	-.9
1959			71	72	.7	.6	.7	.9
Age of dam:								
3,4,11 yrs.			80	82	-.1	-.1	-.1	-.1
5,10 yrs.			55	45	.0	.0	.1	.1
6,7,8,9 yrs.			84	79	.2	.0	.1	.0
Sires:								
1	1	57	10	7	.0	.2	.2	-.1
2	1	57-59	26	25	-.1	-.2	-.1	-.2
15	1	59	7	4	-.3	.0	-.1	.1
3	6	57-59	21	25	.4	.0	.3	.0
4	6	57-59	24	20	-.2	-.2	-.4	-.3
5	9	57-59	21	27	.3	.5	.5	.1
6	9	57-59	20	17	.2	.0	.3	-.1
16	10	59	4	8	.1	.3	.1	.5
17	10	59	7	5	-.4	-.3	-.3	-.1
7		57	8	4	-.3	.3	-.3	.4
8		57	2	2	-.6	-.4	-1.1	-.1
9		57	7	2	.8	-.3	.4	.6
10		58	9	7	.1	.4	.2	-.1
11		58-59	13	16	-.6	-.3	-.3	-.4
12		58-59	15	12	-.1	-.2	.1	-.4
13		58-59	19	19	.2	.1	.3	.0
14		59	6	6	.4	.0	.3	.3
Yearling age			219	206	.0051	.0068	.0025	.0056

[a]Based on feeder grades. High, middle, and low choice values are 12, 11, and 10, respectively.
[b]Estimates of means at 590 days of age.
[c]Constants expressed as deviations from the mean.

Table 5.--Average serum protein percentages at weaning age[a] (unadjusted data)

Sex	N	Serum proteins			
		Albumin (Percent)	Alpha globulin (Percent)	Beta globulin (Percent)	Gamma globulin (Percent)
Bull calves:	59				
Mean		51.1	18.2	11.1	19.6
S. Dev.		5.1	2.0	2.6	3.9
C. Var. (percent)		10.0	11.0	23.4	19.9
Heifer calves	45				
Mean		51.4	18.1	12.6	17.9
S. Dev.		6.6	2.7	5.7	4.1
C. Var. (percent)		12.8	14.9	45.2	22.9
Bulls and heifers	104				
Mean		51.3	18.2	11.7	18.9
S. Dev.		5.8	2.3	4.3	4.1
C. Var. (percent)		11.3	12.6	36.8	21.7

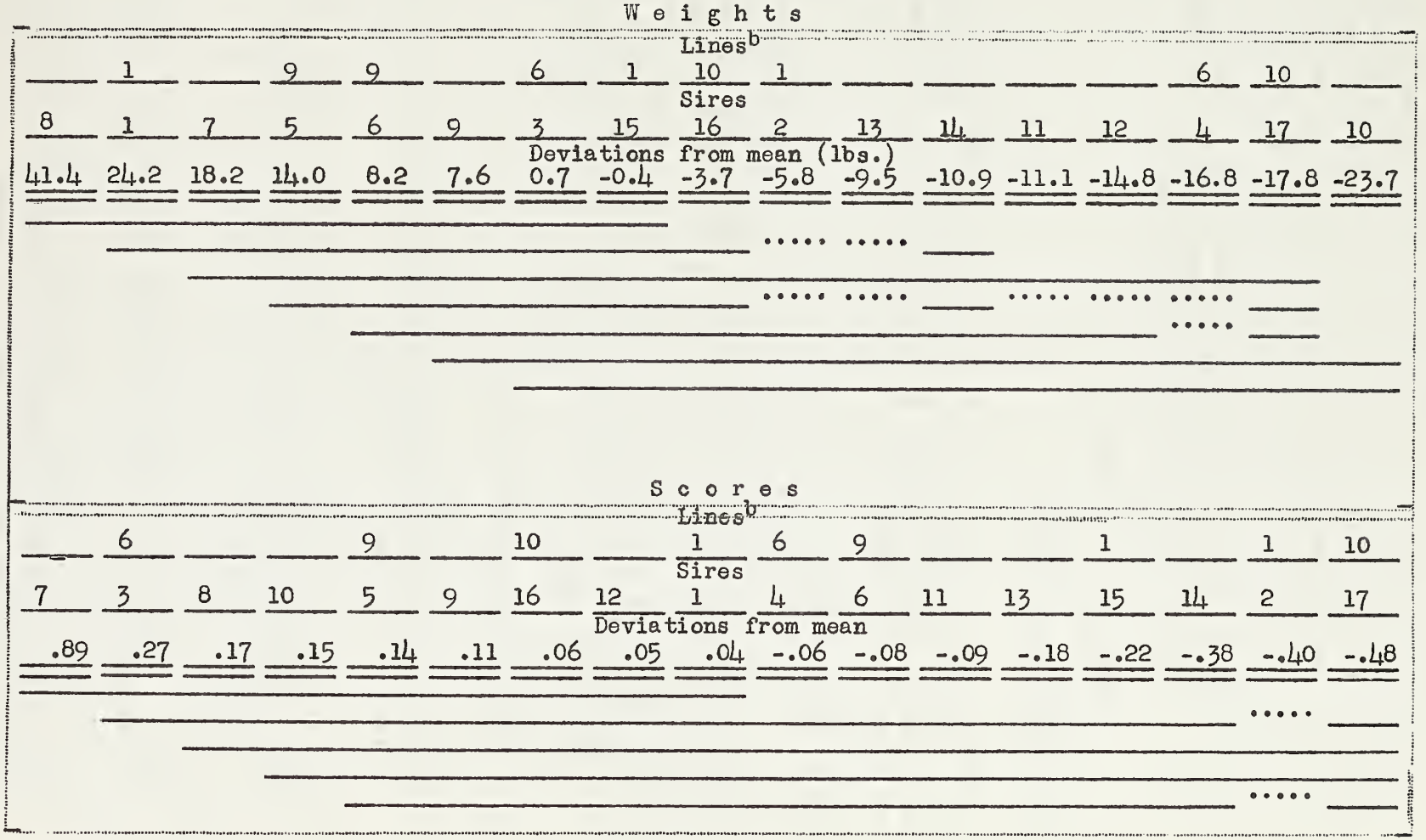
[a]Mean weaning age of 235 days, with range from 193 to 259 days.

Table 6.--Evaluation of effects of sex, sire, and environmental factors on serum protein percentages

Variable	D.F.	Mean squares			
		Albumin	Alpha globulin	Beta globulin	Gamma globulin
Sex	1	8.64	1.98	72.06*	99.76*
Age of dam[a]	2	11.81	3.02	45.92	15.53
Sire	4	18.46	2.08	42.36*	32.75
Age of calf	1	219.01	.73	49.76	47.59
Error	95	32.57	5.74	16.32	14.59

[a]Age of dam classes were as follows: 3, 4, 11; 5, 10; 6, 7, 8, 9.
*$P < 0.05$.

SAN CARLOS WEANING WEIGHTS AND CONFORMATION SCORES
1957 through 1959
Comparisons Among Sires
(Duncan's Multiple Range Test)[a]



[a]Kramer, C. Y. 1957. Biom. 13:13-18. Probability level .05.
[b]Lines refer to Miles City lines from which sires were obtained. Where lines are not designated, sires were produced in San Carlos herd or other private herd.

Application of Findings:

The analyses of growth data and scores provided information that will be useful in formulating selection procedures. A partial evaluation of the sires from the Miles City station and other sources also was obtained. The latter information in combination with additional analyses will furnish the basis for a contemplated project revision.

The analyses of serum proteins provided information of value in planning a more extensive study in which the association of serum protein with growth and future productivity will be investigated.

VI. Work Planned for the Future:

Empire and Arivaca Ranches

Emphasis will be placed upon the completion of analyses of post-weaning data. Adjustment factors and heritability estimates will be calculated. Correlations among pre-weaning and post-weaning traits will be computed and selection procedures will be formulated.

Apache Tribal Herd

Emphasis will be placed upon further analyses of growth data accumulated on calves dropped in 1957, 1958, and 1959. Attention will be devoted to a more complete evaluation of the breeding merit of the sires from the Miles City station. Statistical analyses of the blood and liver data will be continued as time permits. The project will be revised during the coming year if the information obtained from the existing data indicatesthat a revision would be advantageous.

VII. Publications and Manuscripts:

Diven, R. H., O. F. Pahnish, C. B. Roubicek, E. S. Erwin, and H. M. Page
1960. Vitamin A and carotenoid interrelationships in bovine plasma and liver. J. Dairy Sci. 43:1632.

Diven, R. H., O. F. Pahnish, C. B. Roubicek, E. S. Erwin, and H. M. Page
1960. Heritability of vitamin A and carotenoid concentrations in bovine liver and plasma. (Abs. 5) J. Animal Sci. 19:1213.

Pahnish, O. F.
1960. A comparison of weight and grade averages on the progeny of seventeen sires. University of Arizona Cattle Feeders' Day Report, p. 33.

Pahnish, O. F., E. B. Stanley, Ralph Bogart, and C. B. Roubicek
1960. Sex and sire influences upon the 270-day weaning weights of Southwestern range calves. (Abs. 22) J. Animal Sci. 19:1225.

Pahnish, O. F., E. B. Stanley, Ralph Bogart, and C. B. Roubicek. 1961. Influence of sex and sire on weaning weights of Southwestern range calves. J. Animal Sci. (In press.)

Pahnish, O. F., C. B. Roubicek, and Farris Hubbert, Jr. 1961. Influences of sex, sire, and environmental factors on protein fractions in the blood serum of range calves. (Manuscript prepared.)

Cattle Inventory — PROJECT SUMMARY
Purebred — Arizona Agricultural Experiment Station

Breed	Hereford
Line	Apache
Bulls, 12 months or over	98
Cows, 2 years or over	421
Heifers, yearlings	130
Bull calves	133
Heifer calves	88
Estimated cash value[1]	$240,000

[1]Cooperative project. No accurate method of determining percentage of use for breeding project.

Cow Production Data — 1960 calf crop

Breed	Apache Hereford
Cows bred to calve as 2-yr.-olds	None
Calves born from 2-yr.-olds	None
Cows bred to calve at 3 yrs. and up	301
Calves born from 3-yr.-olds and up	
Alive	267
Dead	4
Total	271
Calves weaned	237
Percent calf crop	
Birth[1]	89
Weaning[2]	79

	Bulls		Heifers	
	No.	Av.	No.	Av.
Average				
Birth weight	133	81	134	76
Weaning age	239		238	
Weaning weight	119	532	118	470
Adjusted weaning weight[3]	119	519	118	458
Weaning score				
Condition	119	11.3	118	11.4
Conformation[4]	119	11.3	118	11.4

See next page for footnotes.

[1]Calving percentage based on calves born alive and exposed cows still in herd during calving season

[2]Weaning percent based on calves weighed at weaning time and cows in herd during calving season less cows sold before weaning time with calves at side

[3]Weights adjusted to 230 days of age and to a mature dam basis.

[4]Score based on feeder grade. Scores of 10, 11, and 12 are low, middle, and high choice, respectively

Land, Physical Facilities, and Equipment Used

Item	Number	Actual cash value	Percentage used for breeding project[1]
Apache Reservation			
Land	35 sections	$560,000	
Fencing	55 miles	27,000	
Corrals and scales	-	4,000	
Water supply	-	15,000	
	Total	$606,000	
Experiment Station			
Laboratory facilities	-	22,000	25

[1]Owned by private operators. No accurate method of determining percentage of use for breeding project.

UNIVERSITY OF CALIFORNIA

I. Station: California Agricultural Experiment Station, Davis, California

II. Project Title: Breeding experiments to investigate the nature of genetic improvement in beef cattle productivity with special emphasis on the performance of inbred lines and their crosses. (State Project 1216).

III. Personnel:

Experiment Station:
W. C. Rollins, F. D. Carroll, K. Sittman, and W. Stansfield

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Testing bulls directly and by use of progeny for rate of gain, efficiency of gain, and earliness of maturity.

This study has been completed and a manuscript has been submitted for publication.

Data on growth during the suckling period is being gathered in the purebred Hereford herd according to plan.

The selection index study of weaning weight and weaning grade continues according to the plan outlined in previous reports. Mr. K. Sittmann, a Ph. D. candidate in genetics, probably will complete this study about the end of this calendar year.

Line, linecross, and topcross comparisons of the California inbred Rover line with various Colorado inbred lines.

The comparison of linecross and inbred bulls in topcross tests in cooperator herds is proceeding favorably at one ranch (Rector) and yielded no information at the other (Flourney), since in the latter case the breeding herds assigned to each bull were run together, with the result that calves could not be identified accurately as to sire.

The results at weaning time and at the end of the stocker period in the Rector herd are represented in table 1. There is a statistically significant ($P < 0.001$) sex x sire interaction for weight. This same sort of interaction has been found in another experiment (K.C.L.C. - Economic Quality beef project). In this latter case, the matings, fortunately, can be and are being repeated to further test the genuineness of the

interaction. If this sort of apparent genotype-sex interaction really exists and is of sufficient frequency and magnitude, it could have an important effect on selection methods and results.

The Rector steers are in the feed lot now and later will be followed through the slaughter house.

The entire series of comparisons between the Brae Arden and Rover lines at Colorado, Mississippi, Oklahoma, and California will be completed during the ensuing year.

Brahman-Hereford crossbreeding experiment:

The first of two manuscripts is ready to be submitted for publication.

Application of Findings

A critical survey of the literature supports the results of two University of California crossbreeding experiments, namely, Herefords out-perform Brahman crosses with respect to gain and efficiency of gain in the feed lot during cool weather but the Brahman crosses are superior during the heat of the summer both on pasture and in the feed lot.

Bulls group fed an essentially roughage ration for four months postweaning can be effectively selected on the basis of weight for age at the end of the period. Effective selection in this case means picking the bulls that produce fast, efficient-gaining steers that mature early enough at the proper weight.

For bulls of improved beef type (grading 2- to 2+ in the U. C. System) the following genetic correlations were found in University of California experiments:

a. Yearling weight and conformation are not correlated.
b. Conformation is not correlated with earliness of maturity.
c. Weight is positively correlated with earliness of maturity.

VI. Work Planned for the Future:

The suckling gains in the linebred Hereford herd will be analyzed along with a study of the effect of inbreeding on various traits in the line. The line has been subjected to selection pressure while being inbred.

A project revision is in order. A petition to discuss such a revision will be made at the coming technical committee meeting.

VII. Publications and Manuscripts:

Rollins, W. C.
1961. Effective selection of yearling beef bulls fed an essentially roughage ration. (Submitted to Calif. Agr.).

Rollins, W. C., F. D. Carroll, and N. R. Ittner
1961. A comparison of the performance of 3/4 Hereford-1/4 Brahman calves--live animal studies in two climatic environments. (To be submitted to J. Anim. Sci.).

Rollins, W. C., F. D. Carroll, J. W. T. Pollock, and M. N. Kudoda
1961. A beef cattle progeny test for gain, efficiency, carcass conformation, and earliness of maturity. (Submitted to J. Anim. Sci.).

Sittmann, K., W. C. Rollins, and J. W. Kendrick
1961. A genetic analysis of the double cervix condition in cattle. J. Hered. 52:26-33.

VIII. The project summary is the same for this project as 1938.

Table 1.--Weaning weight and grade of Rover bull 441 and Rover × Brae Arden crossline bull 435, July 7, 1960, one week after weaning--Rector Ranch

441				435			
Steer		Heifer		Steer		Heifer	
Weight	Grade	Weight	Grade	Weight	Grade	Weight	Grade
520	83	470	85	495	83	425	84
460	84	535	87	540	85	460	85
495	83	360	83	460	83	405	85
495	82	465	84	415	84	460	87
545	84	465	86	520	87	570	87
665	87	450	85	520	83	495	86
500	87	500	86	435	87	510	88
510	87	410	85	540	87	510	91
510	89	410	83	585	88	465	86
520	87	440	86	525	84	480	85
420	88	490	87	410	85	480	87
490	88	350	83	460	84	475	87
		470	88	440	84	500	91
		415	85	505	87		
				600	86		
				555	88		
				525	87		
				405	85		
				380	85		
511	86	445	85	490	85	480	87
Yearling weights and grades (4/26/61):							
807	86	698	85	771	86	722	86

UNIVERSITY OF CALIFORNIA

I. Station: California Agricultural Experiment Station, Davis, California

II. Project Title: A comparison of the live performance and carcass traits of crossbred Hereford-Angus calves and Hereford-Charbray calves with calves of their respective parental breeds (Project 1930).

III. Personnel:

Experiment Station:
W. C. Rollins, F. D. Carroll, K. Sittmann, and W. Stansfield

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

The experiment is proceeding according to plan. The animals of the first of two calf crops are now in the feed lot at Davis. They will be marketed in June and July.

The second calf crop is on the ground at the various cooperating ranches and will be brought to Davis during the summer and early fall.

Two modifications have been made in the original plan, (a) steer and heifer progenies have been obtained from each bull, rather than just steers, because of unfavorable sex ratios in some instances, and (b) the animals are being fed individually rather than by sire groups.

Table 2 shows the number and sources of calves on test. In looking at table 3 it should be remembered that possible sire effects on the straightbred vs. the crossbred comparison will not be controlled until the results of the second calf crop have been averaged with those of the first.

Application of Findings: None

VI. Work Planned for the Future: As outlined in the project

VII. Publications and Manuscripts: None

Table 2.--Calves for crossbreeding experiment--first calf crop

Roney

Herd 1				Herd 2			
Angus	(74)	XB	(74)	Angus	(76)	XB	(71[a])
♂	♀	♂	♀	♂	♀	♂	♀
00	04	20	36[b]	12	10	30	31
01	05	21		14	11	33	32
02	06	22[c]		15	13	34	35
03				16			

[a]Sire's identification number
[b]Mistaken brand
[c]Red crossbred

Schneider

Herd 1				Herd 2			
Heref.	(8)	XB	(8)	Heref.	(00)	XB	(00)
♂	♀	♂	♀	♂	♀	♂	♀
40	42	60	61	50	51	72	70
41	43	62	64	52	53		71
44	45	63	65	55	54	74	73
46		66				76	

Johnson				Mets			
Heref.	(431)	XB	(AA73)	Charol.	(AA40)	XB	(433)
♂	♀	♂	♀	♂	♀	♂	♀
80	81	92	90	201	200	100	101
82	84[a]	93	91	202[b]	203	102	104
83	85	95	94	205	204	103	106
86			96	206		105	

[a]Died
[b]Sold, too wild

Table 3.--Crossbred experiment--first pre-feedlot shrunk weight on 11/15/60--summary sheet

Herd	Breed of calf	(Sire)	No. males	Av. male weight	No. females	Av. femal weight
Roney, 1	Angus	(74)	4	567.8	3	520.7
Roney, 1	XB	(74)	3	651.7	1	592.0
Roney, 2	Angus	(76)	4	635.3	3	562.3
Roney, 2	XB	(71)	3	584.3	3	528.0
Schneider,1	Hereford	(8)	4	515.0	3	541.3
Schneider,1	XB	(8)	4	563.5	3	471.7
Schneider,2	Hereford	(00)	4	475.3	3	471.7
Schneider,2	XB	(00)	5	537.4	2	479.5
Johnson	Hereford	(431)	4	432.8	3	522.7
Johnson	XB	(AA73)	3	541.7	4	544.0
Mets	Charolais	(AA40)	4	537.5	3	553.3
Mets	XB	(433)	4	547.0	3	572.7

Hereford-Angus					Hereford-Charolais				
		♂♂		♀♀			♂♂		♀♀
XB	(15)	584	(9)	518	XB	(7)	544	(7)	558
SB	(16)	548	(12)	524	SB	(8)	486	(7)	538
Δ		36		- 6	Δ		58		20

Arithmetic averages of averages, i.e., unweighted
SB = Straightbred
XB = Crossbred

Cattle Inventory — PROJECT SUMMARY — Date: June 1961
Purebred — California Agricultural Experiment Station

Breed	Hereford	Hereford	Hereford		
Line	Rover	Rover × Brae Arden	Rover × (Brae Arden × Rover)		
Station	Davis	Davis	Davis		
Bulls, 12 mos. or over	13	3	1		
Cows, 2 yrs. or over	45	15	0		
Heifers, yearlings	16	0	3		
Bull calves	9	0	4		
Heifer calves	13	0	0		
Percentage used for breeding project	100	100	100		
Estimated cash value	$35,520	$6,660	$2,960		

Grade

Breed	Hereford	Hereford × Angus	Angus	Charolais	Hereford × Charolais
Station	Davis	Davis	Davis	Davis	Davis
Steer calves	12	14	8	3	7
Heifer calves	8	10	6	3	7
Percentage used for breeding project	0	0	0	0	0
Estimated cash value	$3,000	$3,600	$2,100	$900	$2,100

California Agricultural Experiment Station

Cow Production Data

Breed	Hereford		Hereford	
Line (refers to breeding of calf)	Rover × Rover		Rover × (Rover × Brae Arden)	
Cows bred to calve as 2-yr.-olds	8		0	
Calves born from 2-yr.-olds				
Alive	5		0	
Dead	1		0	
Cows bred to calve at 3 yrs. and up	41		11	
Calves born from 3-yr.-olds and up				
Alive	30		6	
Dead	1		2	
All calves born				
Alive	35		6	
Dead	2		2	
Total	37		8	
Calves weaned	31		6	
Percent calf crop*				
Birth	75% *1		73% *3	
Weaning	63% *2		54% *4	
	Bulls	Heifers	Bulls	Heifers
	No. Av.	No. Av.	No. Av.	No. Av.
Average:				
Birth weight	18 75.8	18 70.7	4 80.2	4 70.8
Weaning age	243	-	239	224
Weaning weight	14 524	17 452	3 457	3 388
Adjusted weaning weight - 180 days	408	375	363	326
Weaning score:				
Condition				
Conformation	14 87.7	17 87.5	3 84.0	3 84.3

* All calves are singles

General formula:

$$\% \text{ birth} = \frac{\text{No. cows calving}}{\text{No. cows exposed}}$$

$$\% \text{ weaning} = \frac{\text{No. cows weaning calves}}{\text{No. cows exposed}}$$

$$*1 = \frac{37}{49} = 75\%$$

$$*2 = \frac{31}{49} = 63\%$$

$$*3 = \frac{8}{11} = 73\%$$

$$*4 = \frac{6}{11} = 54\%$$

California Agricultural Experiment Station

Feed-lot Performance — Date: June 1961

Breed	Hereford	Hereford
Line	Rover	Rover × Grade
Sex	Bulls	Steers
Number on test	14	35
Average:		
Age on test	444 days	ca. 16 mos.
Initial weight	753	691
Initial score		
Condition	0.86*	Feeders
Days on test	112	133
Gain		
Total	325	327
Average	2.90	2.46
Efficiency of feed utilization		
lbs. TDN/100 lbs. gain	474.3	448.9
Final weight	1078	1018
Final score		
Condition*	5.3	6.4

* 8 + 5 + 2 +
7 Choice 4 Good 1 Standard
6 - 3 - 0 -

Young Animals on Feed[1] — Date: June 1961

Grade	Hereford	Hereford × Angus	Angus	Charolais	Charolais × Hereford
Bulls	-	-	-	-	-
Heifers	8	10	6	3	7
Steers	12	14	8	3	7

[1] All individually fed

Land, Physical Facilities, and Equipment Used — Date: June 1961

Item	Number	Actual Cash Value	Percentage used for breeding project
Barns and corrals	3 only	$100,000	75
Irrigated pastures	46 acres		100
Drylots and pastures	14 acres		100

UNIVERSITY OF CALIFORNIA

I. Station: California Agricultural Experiment Station, Davis, California

II. Project Title: Genetic control of hereditary deficiencies in beef cattle with special emphasis upon dwarfism

III. Personnel:

Experiment Station:

P. W. Gregory, F. D. Carroll, G. P. Lofgreen, L. M. Julian, W. S. Tyler, L. M. Holm, J. P. Hughes, and Wilmer J. Miller

U. S. Department of Agriculture, Agricultural Research Service

R. T. Clark, Coordinator

IV. Nature and Extent of Work Done This Year:

Although much new work was undertaken, most of the progress herein reported are continuations of studies that have been under way for several years. The most significant contributions are in the field of genetics through the disciplines of anatomy, histology, physiology, and biochemistry. Objective body and skeletal measurements have made substantial contributions to the genetic studies.

The outstanding accomplishments are:

1. Standards of height and weight for mature females of comprest, brachycephalic, and dolichocephalic achondroplastic mutants and nonachondroplastic control Herefords.

2. The achondroplastic mutants, comprest, short-headed dwarfs, and long-headed dwarfs are genetically related and form a complex.

3. The Dexter achondroplasia is a complex which is genetically related to the achondroplastic mutants in (2) above.

4. Two animals that qualify as the Dexter type, both phenotypically and genotypically, have been synthesized--one from mating the achondroplastic mutants comprest, brachycephalic, and dolichocephalic dwarfs.

5. Metacarpal standards for control Herefords and brachycephalic dwarfs now are available.

6. It now is clearly established that some animals of comprest type and subnormal in size exhibit an intermediate fusion time of the sphenoccipital synchondrosis between eight and eighteen months of age.

7. The lumbar articulation has been investigated in skeletons of 207 brachycephalic, achondroplastic mutants obtained from the California anatomy collection, covering an age range of from one day to eight years. This analysis revealed that the arthrodial articulation type occurs in young animals and the trochlear type in mature animals. Transitional animals exhibiting both types of articulation stages occur between the ages of from 123 to 488 days. It is clear that the type of articulation is a function of age and is developmental in nature.

8. Extract from the anterior pituitary of brachycephalic cattle dwarfs injected into the Snell dwarf mouse mutant was as effective in stimulating growth and fertility as the extract from the anterior pituitary from normal cattle. This confirms data from anatomy that the brachycephalic bovine dwarf and the Snell mouse dwarf are not homologous.

9. The cooperative test in collaboration with the Oregon station of a bull from one of their lines has provided some unique data that promises to prove most valuable. The test cows to which the bull was mated were markedly subnormal in size and the test progeny also were subnormal in size, and some qualify as typical achondroplastic types that now are recognized by investigators. These test progeny appear to be an example of herd deterioration that is comparable to the "running out of a line" that commonly occurs in closed herds. There is strong evidence that genes correlated with the achondroplastic complex are implicated in the deterioration observed. The investigators of the Oregon and California stations have considered the advantages of pooling all data from the two stations and making a comprehensive report.

10. Progress continues on the cooperative test in conjunction with the New Mexico and Arizona stations to determine the relationship of the extreme hydrocephalus condition produced by some animals of the New Mexico station to dwarfism. The bull being tested at the California station has produced 38 progeny from potential dwarf-producing comprest cows, brachycephalic dwarfs, and from his own daughters; eight or 10 more cows are yet to calve in the 1961 season. He has sired one hydrocephalic dwarf from his own daughter but no brachycephalic or dolichocephalic dwarfs. It now is certain that he sires some progeny that are subnormal in size that resemble the comprest type and these are regarded as significant. Further mating tests will be made after all the 1961 calves are on the ground.

11. Much progress has been made concerning the improvement of the test for potential achondroplastic production.

Application of Findings

These studies contribute to an insight upon normal and specific types of subnormal growth within cattle populations. They also relate specific qualitative and quantitative traits of growth expression in living mutant forms to specific anatomical skeletal characteristics in the different stocks. The studies are throwing light on the nature of herd deterioration (loss of vigor) that is occurring in registered and commercial herds; also indicated is the nature of the processes essential for the restoration of vigor (heterosis) from the mating of different deteriorated types. The data also can provide pertinent information concerning the relationship of specific mutant control stocks to carcass yield.

VI. Work Planned for the Future:

Attention will be devoted to the completion of all the unfinished studies. Study of the nature of the nature of hydrocephalus and its possible relationship to achondroplasia will be pursued. Factors affecting herd deterioration and the restoration of vigor will receive attention. Much time will be devoted to the preparation and publication of manuscripts.

VII. Publications and Manuscripts:

Fowers, Karen S., W. S. Tyler, L. M. Julian, and P. W. Gregory
1960. Articulation of the lumbar vertebrae in brachycephalic bovine dwarfs. Anat. Rec. 138(3):349.

Gregory, P. W., L. M. Julian, and W. S. Tyler
1960. Genetic relationships of some bovine achondroplastic mutants. Rec. Genet. Soc. Am. 29:72.

Gregory, P. W., W. S. Tyler, and L. M. Julian
1960. Evidence that the Dexter is genetically related to recessive achondroplasia. Anat. Rec. 138(3):353-354.

Gregory, P. W., L. M. Julian, and W. S. Tyler. Bovine achondroplasia.
1960. I. Progeny from crossing brachycephalic with dolichocephalic dwarfs. J. Hered. (in press).

Gregory, P. W., W. S. Tyler, and L. M. Julian. Bovine achondroplasia.
1960. II. The Dexter is related to recessive achondroplasia. J. Hered. (in press).

Tyler, W. S., L. M. Julian, and P. W. Gregory.
1960. Standard values of metacarpal indices for achondroplastic brachycephalic dwarfs and controls. Anat. Rec. 138(3):385.

Carroll, F. D., and P. W. Gregory,
1961. Responses of the Snell dwarf mouse to pituitary tissue from a bovine dwarf mutant. MS completed.

Gregory, P. W., W. S. Tyler, and L. M. Julian
1961. Bovine achondroplasia. IV. Articulation of the lumbar vertebrae in brachycephalic dwarfs. Growth (in press).

Tyler, W. S., L. M. Julian, and P. W. Gregory
1961. Bovine achondroplasia. III. Standard metacarpal indices for brachycephalic dwarfs and control cattle. Am. J. Vet. Res. (in press).

UNIVERSITY OF CALIFORNIA DWARF HERD INVENTORY
June 1, 1961

	Number	Total
1. Brachycephalic Dwarfs		
Females, breeding age	23	
Females, yearlings	-	23
2. Dolichocephalic Dwarfs		
Females, breeding age	22	
Females, yearlings	5	27
3. Comprest Type		
Comprest (descendants of Colorado Domino 68)		
Females, breeding age	6	
Females, mature	6	
Females, yearlings	8	20
4. Recurrent Comprest		
Females, breeding age	3	
Females, yearlings	1	4
5. Synthetic Comprest		
Females, breeding age	13	
Females, yearlings	1	14
6. Bulls, Mature	12	12
7. Bulls, Yearlings	18	18
8. Heifers, Yearlings (Not included anywhere else)	4	4
9. 1961 Calf Crop		
Females	16	
Males	16	32
Total		154

COLORADO STATE UNIVERSITY

I. Station: Colorado Agricultural Experiment Station, Fort Collins, Colorado

II. Project Title: Improvement of beef cattle through breeding. A study of inbreeding and the crossing of inbred lines within the Hereford breed (R & M 26).

III. Personnel:

Experiment Station:

H. H. Stonaker, Kent Riddle, T. M. Sutherland, T. R. Blackburn, G. O. Harwin, Ellen A. Norris, J. B. Armstrong, K. R. Hartman

U. S. Department of Agriculture; Agricultural Research Service

R. T. Clark, Coordinator

IV. Nature and Extent of Work Done This Year:

Progeny Tests

Results of progeny tests at Mississippi and California Experiment Stations, at BCI, Codding-Armour, and ranch cooperators are reported in Colorado General Series 753. In addition, BCI reported weaning weights of 135 naturally sired calves and 119 artificially sired calves by Brae Arden 5012 on the Davis Ranch, Belle Fourche, South Dakota. The Brae Arden 5012's calves were 41 and 33 pounds heavier for steers and heifers, respectively, than the calves sired naturally by range bulls. On the Dean Brown Ranch, Santa Ynez, California, the following results were obtained in adjusted weaning weights. The bulls were bred artificially to commercial Hereford cows.

Line of sire	Adjusted weaning weights			
Commercial cattle	Number	Steers	Number	Heifers
Brae Arden (Colorado)	(8)	497	(7)	475
Line 1 (Miles City)	(15)	437	(6)	448
San Juan (Colorado)	(2)	444	(3)	491
Royal (Colorado)	(4)	474	(9)	477
Prospector (Colorado)	(9)	446	(8)	486
Tiberius (SLO)	(8)	476	(9)	457
Beau Donald	(8)	442	(7)	463
Purebred cattle		Bulls		Heifers
Brae Arden	(15)	504	(15)	482
Line 1	(11)	437	(10)	477

To date a ranking of sires on weight of progeny at stations and ranches does not indicate important genotype-environment interactions. Sires of best progeny groups at Fort Lewis seem to perform fairly similarly in crosses elsewhere. It seems well documented that sires now are known which can increase efficiency of feed-lot gains of their progeny by 2 to 4 percent. More striking are strains which can be used to increase calf production by 10 to 20 percent. The potential increase in wealth from this in Colorado can be 8 to 16 million dollars from cattle ranches and 1-1/2 to 3 million dollars from cattle feed lots.

Correlations with Antigens

The semen morphology, daily gain, and feed utilization of inbred yearling bulls were tested against the presence or absence of selected blood antigens. No consistent association was found in this study by W. Heuermann (1961).

Correlations with Marbling

A multiple correlation of 0.59 was found between marbling and slaughter weight (-0.66), daily gain (0.53), percent kidney knob (0.35), slaughter age (0.27), days on feed (-0.06), feed per pound of gain (0.10), rib fat thickness (0.20), percent fat (0.10), percent round (0.04), condition score (0.06), and circumference of heart girth (0.18). The betas are in parentheses (Harwin, et al. 1961).

V. Work Planned for the Future:

Studies are under way on inheritance of teat and udder shape, and on interior pelvic sizes of two-year-old heifers. Preliminary plans are being made for studies on the inheritance of variations in chemical composition of beef.

VI. Publications and Manuscripts:

Stonaker, H. H.
1960. Correlating beef cattle breeding results. Am. Soc. Animal Prod. Meetings. (Unpublished).

Harwin, G. O., H. H. Stonaker, and M. H. Hazaleus
1961. Factors associated with marbling in yearling beef carcasses. Am. Soc. Animal Prod. West. Sect. Proc. 12:XX-1-6.

Heuermann, W.
1961. The relationship of blood group systems with performance in Hereford cattle. M.S.Thesis. Colorado State University, Ft.Collins.

Moore, Donald B., H. H. Stonaker, and Kent Riddle. 1961. Factors influencing comparisons of Hereford bulls for rate of gain. J.Anim. Sci. 20(2):255-259.

Cattle Inventory PROJECT SUMMARY

Purebred Colorado Agricultural Experiment Station 5-27-61

Breed	Hereford					
Line	Bonanza	Brae Arden	Colo-rado	Don	Monarch	Pros-pector
Bulls, 12 mos. or over	1+3	2+3	1+3	1+1	1+4	2+2
Cows, 2 yrs. or over	11	33	9	17	19	20
Heifers, yearlings	4	6	0	7	8	7
Bull calves	2	16	0	8	7	9
Heifer calves	5	13	5	5	9	14
Percentage used for breeding project	100	100	100	100	100	100
Estimated cash value						

Breed	Hereford					
Line	Real Prince	Rover	Royal	San Juan	Tarring-ton	
Bulls, 12 mos. or over	1+2	0+2	3+4	2+3	1+2	
Cows, 2 yrs. or over	5	3	17	24	11	
Heifers, yearlings	5	4	6	5	2	
Bull calves	7	0	1	11	0	
Heifer calves	2	0	0	5	0	
Percentage used for breeding project	100	100	100	100	100	
Estimated cash value						

Breed	HXA-Sh.					
Line	Cross-bred	Control	On lease			
Bulls, 12 mos. or over	0+2	1+6	4			
Cows, 2 yrs. or over	9	13	98			
Heifers, yearlings	0	3	3			
Bull calves	2	7	-			
Heifer calves	5	7	-			
Percentage used for breeding project	100	100	100			
Estimated cash value						

Colorado Agricultural Experiment Station

Cow Production Data — 1960 Calving

Breed	Hereford		Hereford	
Line	Bonanza		Brae Arden	
	Inbreds	Linecrosses	Inbreds	Linecrosses
Cows bred to calve as 2-yr.-olds	1	3	3	2
Calves born from 2-yr.-olds				
Alive	-	2	1	2
Dead	-	-	-	-
Cows bred to calve at 3 yrs. and up	7	5	13	10
Calves born from 3-yr.-olds and up				
Alive	5	1	10	9
Dead	-	-	2	1
All calves born				
Alive	5	3	11	9
Dead	-	-	2	-
Total	5	3	13	10
Calves weaned	4	3	11	8
Percent calf crop				
Birth	62.5	37.5	81.3	83.3
Weaning	50.0	37.5	68.8	66.7
No. bull calves	2	1	8	5
No. heifer calves	2	1	3	3
Average:				
Inbreeding coefficient	.36	.05	.41	.05
Weaning age	188	163	184	191
Weaning weight	360	355	326	418
Adjusted weaning weight - 200 days	504	465	489	457

Colorado Agricultural Experiment Station

Cow Production Data — 1960 Calving

Breed	Hereford		Hereford	
Line	Colorado		Don	
	Inbreds	Linecrosses	Inbreds	Linecrosses
Cows bred to calve as 2-yr.-olds	-	-	-	3
Calves born from 2-yr.-olds				
Alive		-	-	1
Dead	-	-	-	-
Cows bred to calve at 3 yrs. and up	10	6	6	9
Calves born from 3-yr.-olds and up				
Alive	4	-	6	2
Dead	1	-	-	-
All calves born				
Alive	4	-	6	3
Dead	1	-	-	-
Total	5	-	6	3
Calves weaned	3	-	6	3
Percent calf crop				
Birth	50	-	100	25
Weaning	30	-	100	25
No. bull calves	3	-	1	1
No. heifer calves	-	-	5	2
Average:				
Inbreeding coefficient	.45	-	.37	.05
Weaning age	183	-	198	172
Weaning weight	318	-	355	373
Adjusted weaning weight - 200 days	459	-	483	451

Colorado Agricultural Experiment Station

Cow Production Data — 1960 Calving

Breed	Hereford		Hereford	
Line	Monarch		Prospector	
	Inbreds	Linecrosses	Inbreds	Linecrosses
Cows bred to calve as 2-yr.-olds	2	4	3	1
Calves born from 2-yr.-olds				
Alive	1	4	1	1
Dead	-	-	1	-
Cows bred to calve at 3 yrs. and up	7	5	6	8
Alive	7	4	5	7
Dead	-	-	-	-
All calves born				
Alive	8	8	6	8
Dead	-	-	1	-
Total	8	8	7	8
Calves weaned	8	8	5	8
Percent calf crop				
Birth	88.9	88.9	77.8	88.9
Weaning	88.9	88.9	55.6	88.9
No. bull calves	5	3	2	4
No. heifer calves	3	5	3	4
Average:				
Inbreeding coefficient	.28	.05	.33	.05
Weaning age	191	192	188	205
Weaning weight	364	386	367	432
Adjusted weaning weight - 200 days	479	431	497	449

Colorado Agricultural Experiment Station

Cow Production Data — 1960 Calving

Breed	Hereford		Hereford	
Line	Real Prince		Rover	
	Inbreds	Linecrosses	Inbreds	Linecrosses
Cows bred to calve as 2-yr.-olds	1	-	-	4
Calves born from 2-yr.-olds				
Alive	1	-	-	3
Dead	-	-	-	-
Cows bred to calve at 3 yrs. and up	8	8	-	12
Calves born from 3-yr.-olds and up				
Alive	6	1	-	9
Dead	-	-	-	-
All calves born				
Alive	7	1	-	12
Dead	-	-	-	-
Total	7	1	-	12
Calves weaned	7	1	-	12
Percent calf crop				
Birth	77.8	12.5	-	75.0
Weaning	77.8	12.5	-	75.0
No. bull calves	2	1	-	7
No. heifer calves	5	-	-	5
Average:				
Inbreeding coefficient	.31	.05	-	.05
Weaning age	181	202	-	190
Weaning weight	323	345	-	398
Adjusted weaning weight - 200 days	480	342	-	441

Colorado Agricultural Experiment Station

Cow Production Data — 1960 Calving

Breed	Hereford		Hereford	
Line	Royal		San Juan	
	Inbreds	Linecrosses	Inbreds	Linecrosses
Cows bred to calve as 2-yr.-olds	2	4	1	3
Calves born from 2-yr.-olds				
Alive	-	3	-	1
Dead	-	-	-	-
Cows bred to calve at 3 yrs. and up	7	7	10	7
Calves born from 3-yr.-olds and up				
Alive	4	7	6	3
Dead	-	-	1	-
All calves born				
Alive	4	10	6	4
Dead	-	-	1	-
Total	4	10	7	4
Calves weaned	4	10	7	4
Percent calf crop				
Birth	44.4	91.0	63.6	40.0
Weaning	44.4	91.0	63.6	40.0
No. bull calves	2	6	3	2
No. heifer calves	2	4	3	2
Average:				
Inbreeding coefficient	.43	.05	.29	.05
Weaning age	212	193	197	182
Weaning weight	431	418	433	408
Adjusted weaning weight - 200 days	514	454	534	462

Colorado Agricultural Experiment Station

Cow Production Data — 1960 Calving

Breed	Hereford		Hereford	H X A. Sh.
Line	Tarrington		Control	Crossbreds
	Inbreds	Linecrosses		
Cows bred to calve as 2-yr.-olds	-	5	3	6
Calves born from 2-yr.-Olds				
Alive	-	4	3	3
Dead	-	-	-	-
Cows bred to calve at 3 yrs. and up	-	5	10	8
Calves born from 3-yr.-olds and up				
Alive	-	4	9	7
Dead	-	-	-	-
All calves born				
Alive	-	8	12	10
Dead	-	-	-	-
Total	-	8	12	10
Calves weaned	-	7	12	9
Percent calf crop				
Birth	-	80.0	92.3	71.4
Weaning	-	70.0	92.3	64.3
No. bull calves	-	5	8	6
No. heifer calves	-	2	4	3
Average:				
Inbreeding coefficient	-	.05		
Weaning age	181	181	197	198
Weaning weight	-	376	397	491
Adjusted weaning weight - 200 days	-	436	421	516

Colorado Agricultural Experiment Station

Feed-lot Performance — Date: May 15, 1961

Breed	Hereford	Angus	Crossbred
Sex	Bulls	Bulls	Bulls
Number on test	89	2	6
Average:			
Age on test	-	-	-
Initial weight	426	552	525
Days on test	140	140	140
Gain per head			
Total	336.18	340.5	386.3
Average daily gain	2.40	2.43	2.76
Efficiency of feed utilization			
Lbs. TDN/100 lbs. gain	6.66	8.26	7.32
Final weight	763	893	912
Final score			
Conformation	4.8	5.6	5.45

Young Animals on Feed

Purebred — Date: May 15, 1961

	Hereford	Angus	Shorthorn
	Number individually fed	Number individually fed	Number individually fed
Bulls	89	2	-
Heifers	-	-	-
Steers	-	-	-
Grade - Crossbred (H × Angus - Shorthorn)			
Bulls	6		
Heifers			
Steers			

UNIVERSITY OF HAWAII

I. Station: Hawaii Agricultural Experiment Station, Honolulu, Hawaii

II. Project Title: The estimation of genetic and phenotypic parameters in populations of beef cattle in Hawaii and their use in selection programs

III. Personnel:

Experiment Station:

Estel H. Cobb, Oliver Wayman, Isaac Iwanaga, and Valentino Arganosa (also managers of cooperating ranches and their stock handling personnel)

U. S. Department of Agriculture, ARS: R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Weights and conformation scores at weaning, 12 months, and 20 months of age were obtained as planned. The second group of test males were selected at weaning and castrated for progeny testing for rate of gain and carcass characteristics.

The feeding out and slaughtering of the first group of test steers took much time this year. As of July 1, 1961, 19 feed-lot steers and six pasture steers have been slaughtered and the carcass data obtained as planned. The ranking of the 7 sires on the basis of the rate of gain of the steer progeny in the feed lot was compared to the performance of their half-sisters on the ranch. Although the sampling errors are large, the same 2 sires ranked last regardless of which ranking is used. Considerable more data will be needed before any conclusions can be drawn. No comparisons are yet possible on the rate of gain of steers of the feed-lot steers with their half-brothers on pasture. The pasture steers are still on test.

The following table summarizes some of the carcass data by sire for the first 19 steers which have completed the test.

Sire No.	Carcass grade	% ether extract	Dressing % on basis of empty body wt.	% trimmed retail cuts from round, chuck, loin, and rib	% waste	Specific gravity of carcass	Rate of gain on test
301	18.7	4.0	65.6	68.1	17.0	1.0558	2.97
09	17.3	3.15	64.3	68.5	14.9	1.0647	2.66
78	18.3	4.12	65.6	66.9	18.1	1.0500	2.46
948	18.0	4.32	65.8	66.5	17.0	1.0561	2.29
176	18.5	4.38	67.6	68.0	17.2	1.0582	2.14
21	20.0	4.62	66.0	66.1	18.4	1.0550	1.96
134	17.3	4.52	67.6	66.8	18.4	1.0521	1.89

A paper entitled, "Phenotypic Correlations Between Conformation Scores and Liveweights at 8, 12, and 20 Months of Age and Rate of Gain of Beef Cattle", will be presented at the Western Section meetings of the American Society of Animal Production at Moscow, Idaho, in July. A summary of the paper follows.

Data from four ranches involving 220 bulls and 374 heifers were analyzed for the interrelationships among liveweight and conformation scores at 8, 12, and 20 months of age, and the rates of gain from birth to weaning, from birth to 12 months of age, from birth to 20 months of age, and from 8 to 20 months of age. Correlations were computed separately for bulls and heifers, using the pooled sum of squares and crossproducts within year, sire, and ranch.

Correlation coefficients between traits were similar for heifers and bulls. Positive correlations of 0.5 or higher were obtained between weaning weight, 12-month weight, 20-month weight, daily gain from birth to weaning, daily gain from birth to 12 months of age, and daily gain from birth to 20 months of age.

Positive correlations of 0.5 or higher were obtained between weights and conformation scores taken at the same age. Slightly lower positive correlations were obtained between weights and conformation scores taken at different ages.

Negative correlations of -0.2 to -0.5 were obtained between weaning weight or rate of gain from birth to weaning and rate of gain from weaning to 20 months of age.

The pooled correlations after adjustments were made for the differences in age of the animals at the time of weighing and grading are as follows:

Partial Correlation Coefficients Between Conformation Scores and Liveweight at 8, 12, and 20 Months of Age Independent of Age at Weaning

Trait		Weaning score	12-month weight	12-month score	20-month weight	20-month score	Rate of gain weaning to 20 months
Weaning weight	Bulls	.63	.75	.45	.47	.35	-.25
	Heifers	.63	.66	.34	.60	.23	-.47
Weaning score	Bulls		.39	.50	.43	.44	.13[ns]
	Heifers		.44	.48	.28	.31	-.43
12-month weight	Bulls			.52	.59	.31	.06[ns]
	Heifers			.48	.65	.28	-.09[ns]
12-month score	Bulls				.36	.38	.08[ns]
	Heifers				.24	.39	-.07[ns]
20-month weight	Bulls					.59	.60
	Heifers					.49	.41
20-month score	Bulls						.34
	Heifers						.28

[ns] not statistically significant. All other correlations are significant. $P < .01$.

Coefficients of correlation between tenderness as measured by a taste panel and tenderness as measured by the Warner-Bratzler shear machine and various other measures of quality were determined. The data included 60 rib roasts that were roasted under controlled conditions and scored by a panel of eight judges. Only U. S. Standard and U. S. Choice beef grades were represented. The following table summarizes the correlations.

	Warner-Bratzler shear	Loin eye muscle			Marbling score
		% water	% protein	% fat	
Tenderness (score)	-.25[a] -.76[b]	-.62 0	.55 0	.68 .08	.70 .15
Warner-Bratzler Shear		.14 -0	-.01 -.01	-.16 .07	-.18 -.27
% fat (Loin eye muscle)					0.88 0.44

[a]Upper value is total correlation.
[b]Lower value is based on within subclass sum of squares and crossproducts.

VI. Work Planned for the Future:

Continue the analysis of the data. Finish the collection of the carcass data on the test steers from the first group. Start the second group of test steers on test in July 1961.

The collection of conformation scores and liveweights on the cattle at the ranch at 8, 12, and 20 months of age will continue as planned.

A paper covering the beef cattle breeding research at the Hawaii station will be presented at the meetings of the Pacific Science Congress to be held in Hawaii in August 1961.

VII. Publications and Manuscripts:

Cobb, Estel H., Oliver Wayman, and Valentino Arganosa
1961. Phenotypic correlations between conformation scores and liveweights at 8, 12, and 20 months of age and rate of gain of beef cattle. Hawaii Agr. Expt. Sta. Tech. Paper No. 536. (To be presented at the Western Section meetings of the American Society of Animal Production, Moscow, Idaho, July 18, 1961.)

Cattle Inventory PROJECT SUMMARY Date: June 1961
Purebred Hawaii Agricultural Experiment Station

Breed			Hereford
Line			Martin
Station			Hawaii
Bulls, 12 mos. or over			5
Cows, 2 yrs. or over			20
Heifers, yearlings			5
Bull calves			5
Heifer calves			9
Percentage used for breeding project			100
Estimated cash value			$30,000

Grade

Breed	Hereford	Hereford	Hereford
Line	Kaalualu	Kapapala	Line crosses
Station	Hawaii	Hawaii	Hawaii
Bulls, 12 mos. or over	20	15	29
Cows, 2 yrs. or over	266	87	18
Heifers, yearlings	27	19	61
Male calves	18	21	98
Heifer calves	11	29	94
Percentage used for breeding project	100	100	100
Estimated cash value	$136,800	$46,800	$120,000

Cow Production Data

Breed	Hereford	Hereford
Line	Kaalualu & Kapapala combined	Martin
Cows bred to calve at 3 yrs. and up	343	20
Calves born from 3-yr.-olds and up		
Alive	255	10
Dead	5	2
Calves weaned	249	10
Percent calf crop*		
Birth	74.3	50.0
Weaning	72.6	50.0

Cow Production Data--Continued Hawaii Agricultural Experiment Station

	Hereford				Hereford			
	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Weaning age		250.9		252.9		258.0		254.8
Weaning weight**	129	369.6	120	359.1	5	365.0	5	349.0
Adjusted weaning weight - 240 days		354.2		343.0		344.6		333.5
Weaning score Conformation***		3.7		4.1		4.0		4.4

* Based on number of calves alive and number of cows exposed to the bull
** Overnight shrink without feed or water
*** Based on grading system where 9 is highest score and 1 is the lowest

Young Animals on Feed Date: June 1961

	Hereford	
	Number pasture fed	Number group fed
Grade steers	21	20

Land, Physical Facilities, and Equipment Used

Item	Number	Actual cash value	Percentage used for breeding project
Land (Kaalualu)	2,070 acres	$22,700	100% Annual lease value
Corrals, chutes & scale	1 set	5,000	100%
Portable scale	1 only	650	80%
University of Hawaii			
Pasture, irrigated	12.5 acres	12,500	100%
Portable scale	1 only	650	50%
Corrals, chutes, scale and barn	1 set	10,000	90%
Meat laboratory	1 only	75,000	75%
Working horse	1 only	250	80%
Irrigation system	1 only	15,000	60%
Profilometer	1 only	200	100%
Leica camera set	1 only	613	50%
Electronic ejaculator	1 only	544	100%
Monroe adding machine	1 only	238	65%
Friden calculator	1 only	659	80%
IBM electric typewriter	1 only	270	20%
Total		$144,274	

UNIVERSITY OF IDAHO

I. Station: Idaho Agricultural Experiment Station, Moscow, Idaho

II. Project Title: The improvement of beef cattle through: (1) linebreeding within the Hereford and Shorthorn breeds, (2) testing linebred sires within the various lines which will be developed, and (3) determining the relative importance of various reproductive phenomena

III. Personnel:

Experiment Station:
R. E. Christian, C. W. Hodgson, T. D. Bell, and S. E. Slyter

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Performance and production data have been collected according to the project outline.

This year 17 bull calves (11 Hereford, 4 Angus, and 2 Shorthorn) were individually fed for 146 days following weaning to obtain feed-lot gain and feed efficiency. The average rate of daily gain for the 11 Hereford was 1.94 pounds, for the 4 Angus, 1.83 pounds, and for the 2 Shorthorn, 1.89 pounds. The Hereford required 453.8 pounds of total digestible nutrient per 100 pounds of gain, the Angus, 496.0 pounds, and the Shorthorn, 505.4 pounds.

The University of Idaho has initiated a program to progeny test a number of the bulls used in the individual feeding test. Selected breeders in the state have agreed to use two bulls from the University in each of their herds. Each bull will be bred to a randomly selected group of approximately 25 cows. Eight to ten steer calves from each bull will be brought back to the University at weaning time and fed out in the new feeding barn. Production and carcass data will be obtained from these steer calves. To date, two breeders have taken delivery on their bulls and now are using them in their herds. Several other breeders now are being signed up and will take delivery in the near future.

The statewide production testing program for purebred and commercial cattle breeders has been expanded this past year. There now are 62 breeders with over 6,000 cows enrolled in the program.

The study on semen production in the young beef bull as determined with the electro-ejaculator was initiated this year. The regular rectal bull probe furnished with the machine was found to be too large for use in the young bull. Therefore, attempts at collection were made using the ram probe. Only partial success was achieved using this probe, probably because it was too small in diameter. A new probe intermediate in size has been designed and will be used this year.

Application of Findings

The use of a production testing program by the cattle breeders will increase the weaning weight and grade of the calves they produce. This will result in increased income to the cattle breeder. The cattlemen enrolled in the program are being urged to pregnancy-test their cows each fall to eliminate the nonproducers from their herds. Both of these practices have received enthusiastic acceptance by the cattle breeders.

The progeny-testing program being developed for testing the production and carcass characteristics of bulls will be of considerable value to the cattle breeders of the State of Idaho.

VI. Work Planned for the Future:

The statewide production testing program will be expanded to include additional purebred and commercial producers. The data from their herds will be used to calculate correction factors for use in their own herds for such things as age at weaning, sex of calf, age of dam, etc.

The progeny testing of University bulls for production and carcass traits will be expanded as additional cooperators are enrolled. The first calves will become available in the fall of 1962.

The study on age at which young beef bulls first produce semen, and changes in semen quality with age will be continued with the 1961 calves.

VII. Publications and Manuscripts: None.

Cattle Inventory PROJECT SUMMARY Date: June 15, 1961
Purebred Idaho Agricultural Experiment Station

Breed	Hereford	Angus	Shorthorn
Station	Main	Main	Main
Bulls, 12 mos. or over	14	5	4
Cows, 2 yrs. or over	61	22	24
Heifers, yearlings	9	5	5
Bull calves	21	6	13
Heifer calves	24	7	7
Percentage used for breeding project	75	75	75
Estimated cash value	$48,000	$20,000	$24,000

Cattle Inventory--Continued PROJECT SUMMARY Date: June 15, 1961

Grade Idaho Agricultural Experiment Station

Breed	Hereford
Line	Carrier
Station	Main
Bulls, 12 mos. or over	0
Cows, 2 yrs. or over	8
Steer calves	4
Heifer calves	2
Percentage used for breeding project	100
Estimated cash value	$4,000

Cow Production Data

Breed	Hereford	Angus	Shorthorn
Cows bred to calve as 2-yr.-olds	0	0	0
Cows bred to calve at 3 yrs. and up	59	19	22
Calves born from 3-yr.-Olds and up			
Alive	50	15	20
Dead	0	0	0
All calves born			
Alive	50	15	20
Dead	0	0	0
Total	50	15	20
Calves weaned	49	14	20
Percent calf crop			
Birth	84.7	78.9	90.9
Weaning	83.1	73.7	90.9

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Birth weight	23	74.6	27	66.8	8	61.0	7	56.7	13	67.3	7	61.5
Weaning age		156.8		174.2		184.0		179.4		155.6		175.0
Weaning weight	23	336.0	26	329.9	7	378.4	7	329.4	13	357.4	7	317.0
Weaning score	23	4.0	26	3.6	7	3.7	7	4.3	13	4.5	7	4.6

Idaho Agricultural Experiment Station

Young Animals on Feed — Date: June 15, 1961

	Hereford		Angus		Shorthorn	
Purebred	Number individually fed	Number group fed	Number individually fed	Number group fed	Number individually fed	Number group fed
Bulls	11	4	4	0	2	3
Heifers		24		7		7
Steers		4		3		8
Grade						
Bulls						
Heifers		2				
Steers		4				

Feed-lot Performance — Date: June 15, 1961

Breed	Hereford	Angus	Shorthorn
Sex	M	M	M
Number on test	11	4	2
Average:			
Age on test	211.3	225.0	226.5
Initial weight	392.9	424.5	484.0
Initial score	4.3	5.0	6.0
Days on test	146	146	146
Gain per head			
Total	283.6	267.5	276.0
Average daily gain	1.94	1.83	1.89
Efficiency of feed utilization			
Lbs. TDN/100 lbs. gain	453.8	496.0	505.4
Final weight	676.5	692.0	760.0
Final score	4.7	5.2	6.0

MONTANA STATE COLLEGE

I. Station: Montana Agricultural Experiment Station, Bozeman, Montana, and the North Montana Branch Station, Havre, Montana

II. Project Title: Recurrent selection and record of performance selection in open and closed beef cattle herds (W-1, M.S. 873, A.I. 104, North Montana Branch Station 71.)

A. 1. The establishment of inbred lines of registered Hereford cattle, both horned and polled, that will result in improvement in such characteristics as rate and economy of gain, fertility, nursing ability, longevity, and carcass quality.

2. Maintain an outbred herd of Herefords with bulls selected and furnished by the purebred breeders. The bulls are to be primarily good, high-scoring individuals according to breed association standards.

B. 1. Establishment of an improved herd of registered Angus cattle in which the males are selected on a high level of performance as indicated by standard record of performance procedures.

C. 1. Investigate feasibility of breeding for specific combining ability through recurrent selection.

III. Personnel:

Montana State College:
Experiment Stations:
Bozeman, Montana:
F. S. Willson, Leader, A. E. Flower, Leader, R. W. Miller, E. P. Orcutt, and J. R. Dynes

North Montana Branch Station, Havre:
Claude Windecker, Superintendent

U. S. Department of Agriculture, Agricultural Research Service:
J. R. Quesenberry, Superintendent, U. S. Range Livestock Experiment Station, Miles City, Montana
R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Bozeman

In line with a suggestion made by the technical committee last year, we discontinued the cooperative work with the Montana Hereford Association

and the Montana Angus Association. It was done because of the fact that the two associations have been selecting bulls pretty much on the same basis as we have with our Record of Performance procedures, using large, proven sires of older ages. We are discontinuing the test breeding of these two lines on the tester herd at Miles City this year; however, there is a crop of calves from each of our Hereford lines in the feed-lot test at present. This test is not completed as yet; however, they are not doing as well in comparison with the Miles City Line 1 as they did a year ago but our ROP line is showing up better than the so-called Show Type.

We indexed 14 Hereford bulls and 15 Angus bulls at the Bozeman station. The performance was down on the average by about .25 pound per day. We had two of the same sire groups in the test as the year previous, so it must have been due to environmental conditions, either feed or weather. The progeny of the Show Type Hereford bull came close to doing as well as the ROP bull. There was just .05 pound per day average difference.

In making an eleven-year summary as to the trends of the comparisons between our Hereford Show Type and ROP line, we find in adjusted weaning weights (adjusted for 180 days and for age of dam and sex of calf) that the Show Type group have had a slight edge in weaning weights and weaning score. However, the edge has been in favor of the ROP line both in bulls' and heifers' feed-lot gains, as well as in 12-month weight. In the score off feed test, the bulls of the Show Type have had a slight edge, whereas the heifers of the ROP have out-scored the Show Type heifers. We plan to summarize the four years of progeny testing between these two lines on tester cows at Miles City after the close of this year's feeding test.

In the Angus comparisons, the same old Show Type Angus bull out-performed the ROP bull that we secured from California by about .2 pound per day. His calves scored a little higher than the ROP bulls at weaning and at the end of the feed-lot test. We are using a son of this bull to head up our ROP line this year.

At our Red Bluff Research Ranch, we run a four-year summary comparing the productivity of the crossline cows from the Havre station with some outcross cows purchased from good commercial herds in the area. In the 180-day adjusted weaning weight we find that the steers from the Havre cows averaged 397 pounds as compared with 359 pounds for the industry cows, and a score of 82.2 for the crossline as compared to 78.8 for the industry steer calves. The crossline heifer calves averaged 391 pounds as compared to 375 pounds for the industry calves and the same score for both. This gives an average yearly weight advantage in favor of the crossline steer calves of 38 pounds and a 16-pound advantage for the crossline heifer calves.

Havre

Report of Steer Progeny will only be partially complete for this report as only 6 steers have been slaughtered at this report time. A complete and final analysis will be presented at time of W-1 Annual Meeting. Some alterations have been made in 1960-61 feeding program to get maximum gains on cattle. One change was decreasing amount of alfalfa at a faster rate than previous years to permit steers to eat larger amounts of grain. Hay was reduced gradually until the sixth period when it was set at 3 pounds per day to allow for necessary carotene intake.

Gains have averaged appreciably more than in recent years and should be in line with the maximum ability of the cattle to gain. Steers with heavier weaning weights tend to show slightly higher gains at start of feeding trial.

There was a total of 53 station steers and 24 rancher steers started on feed November 1. The final goal of the recurrent selection program is being realized by loaning rancher cooperators bulls of high-gaining ancestry. We are getting back steers from these bulls and rancher cows, also steers from rancher cows by rancher bulls. We have two groups of six each from station sires and two groups of six each from rancher sires. We believe these trials will give us considerably more information on the value of gaining ability in commercial calf production.

It would seem that about 10% gain can be expected from using high-gaining sires with good conformation on the average top rancher set of cows with choice conformation.

This method of testing still gives us a check on rancher steers compared to station steers although not as extensive as when we brought in groups of steers from several ranchers.

It was possible for the first time to feed out several steers from each purebred line. Most of these calves were from two-year-old heifers and were light when put on feed but they have given a good account of themselves. Several of these calves will have bone-fat-lean separation to attempt a determination of difference in lines.

Results of heifer calves wintered on ad lib amounts of good quality second-cutting alfalfa are interesting in that most ranchers state that they cannot get sufficient gain on heifer calves with this type of wintering operation. Most groups of heifers gained in excess of .75 pound per day which is quite satisfactory. It is significant to note that the heifers from Line II, Sire 169, were the highest-gaining group. Sire 169 has one of the highest individual gains and highest progeny gain of any sire used.

Table 1.--Heifer calves fed ad lib second-cutting alfalfa hay, 140 days (1960-61)

Sire	No. of heifers	Initial weight	Final weight	Total gain	Av. Daily gain
Line I, 111	7	405	526	121	.86
Line II, 169	11	399	586	187	1.33
Line III, 115	5	401	538	137	.98
Miles City, 637*	9	420	533	113	.80
Line I, 714, x-line	7	427	548	121	.86
Line I, 717 "	4	454	591	137	.98
Line II, 730 "	4	386	531	145	1.03
Line II, 749 "	2	436	583	147	1.05
Line III, 739 "	5	419	581	131	.93
Line III, 649 "	3	437	562	125	.89

*Control

Special note should be made that all purebred lines and crosslines showed significant gains over the control line. In a comparison of weaning grade, the control heifers were scored down on individual and group score.

Indexed 14 bulls from the three lines. They were fed 168 days. The gains were about the same as last year. Their gains varied from 2.06 pounds to 2.75 pounds for an average of 2.34 pounds per day.

Application of Findings

There continues to be increased interest by the feeder buyers in purchasing calves from high-indexed bulls. The Montana Beef Performance Association reports a gain in membership and in certified calves produced this last year (6,100 calves). There were two privately owned bull-feeding stations custom feeding over 100 bulls for ranchers this year. Montana Beef Performance Association has over 2,300 purebred bulls and heifers in their program. They have a cooperative breeding test in progress with a feeder at Humboldt, Iowa, and the Iowa Extension Service.

VI. Work Planned for the Future:

Bozeman

We will summarize the four years of comparisons with topcrossing our two Hereford lines on Miles City cows. This will include feed-lot performance of their progeny as well as carcass data available. Discontinue the Show Type, ROP comparisons, liquidate the cows with dirty pedigrees in the Show Type herd. We will increase the numbers of cows in our ROP Hereford herd which is now a two-sire line.

Havre

In the future, emphasis will continue with topcrossing station linebred sire with commercial range cows. With rancher cooperators, there will be three cooperators in 1961-62 and three in 1962-63. It is our considered opinion that more testing work needs to be done with ranchers on heifer selection for producing ability. An attempt will be made to secure heifers from cooperating ranchers and wintered with station heifers to gather some information on capability of commercial heifers to increase rancher production to level of station cows. Another phase of the program will be to cross-mate purebred lines and feed out as steer progeny to get an evaluation of hybrid vigor in inbred lines of purebred cattle. Compared to crossline matings, one outcross sire will be secured from Montana State College outcross herd to test against station crossline progeny. This sire will be used on a breeding herd of control cows. Work will be continued on bone-fat-lean and shear test on a sample of each sire progeny and rancher controls.

VII. Publications and Manuscripts:

Blackmore, D. W., J. A. Marchello, and J. J. Urick
1960. Differential growth of males and females in different years. Amer. Soc. Anim. Prod. West. Sect. Proc. 11:VIII-1-4.

Jacobsen, N. A.
1960. More efficient cattle for producers provide better beef for consumers. Montana Farmer-Stockman.

Orcutt, E. P.
1960. Breeding for personality, pounds, and profit! West. Livestock 45(8):63-64.

Urick, J. J.
1960. Age of calf and season as affecting suckling gains on summer range. Mont. State Col. Sixth Annu. Beef Prod. Sch. Proc.

Windecker, Claude
1960. Increasing a herd's productivity and efficiency. Mont. State Col. Sixth Annu. Beef Prod. Sch. Proc. 5:69-73.

Mr. A. E. Flower is at Ames, Iowa, all year working on a Ph. D. summarizing data on the recurrent selection program at Havre.

Cattle Inventory (Bozeman) PROJECT SUMMARY Date: June 14, 1961

Purebred Montana Agricultural Experiment Station

Breed	Angus	Angus	Hereford	Hereford
Line	ROP	Show Type	ROP	Show Type
Station	Bozeman	Bozeman	Bozeman	Bozeman
Bulls, 12 mos. or over	10	7	12[4]	9[5]
Cows, 2 yrs. or over	23	17	33	27
Heifers, yearlings	7[2]	3	9	5
Bull calves	12[3]	6	14	11[7]
Heifer calves	13[6]	7	17	13[8]
Percentage used for breeding project	60	60	60	60
Estimated cash value	$12,500	$7,850	$16,750	$10,650

Grade

Breed	Hereford			
Station	Red Bluff	Ranch		
Cows, 2 yrs. or over	61			
Heifers, yearlings	76			
Steer calves	28			
Heifer calves	28			
Percentage used for breeding project	20			
Estimated cash value	$21,125			

[1] Two crossline yearling heifers
[2] Two crossline heifer calves
[3] One crossline bull calf
[4] Includes 3 bulls at Red Bluff Ranch
[5] Includes 1 bull at Miles City and 1 bull at Red Bluff Ranch
[6] Three crossline heifer calves
[7] One crossline bull calf
[8] Six crossline heifer calves

Cattle Inventory (Havre) PROJECT SUMMARY Date: June 14, 1961

Purebred North Montana Branch Station

Breed	Hereford	Hereford	Hereford	
Line	Line I	Line II	Line III	
Station	Havre	Havre	Havre	
Bulls, 12 mos. or over	5	9	4	
Cows, 2 yrs. or over	22	27	15	
Heifers, yearlings	7	11	5	
Bull calves	13	8	8	
Heifer calves	10	15	6	
Percentage used for breeding project	100	100	100	
Estimated cash value	$12,000	$16,000	$8,000	

Cattle Inventory--Continued Date: June 14, 1961

Grade North Montana Branch Station

Breed	Hereford	Hereford		
Line	M.C.L. 1	Crossline		
Cows, 2 yrs. or over	89	17		
Heifers, yearlings	9	27		
Steer calves	50	7		
Heifer calves	26	8		
Percentage used for breeding project	100	100		
Estimated cash value	$20,000	$8,800		

Cow Production Data (Bozeman)

Breed	Hereford	Hereford
Line	ROP	Show Type
Cows bred to calve as 2-yr.-olds	8	5
Calves born from 2-yr.-olds		
Alive	8	5
Dead	0	0
Cows bred to calve at 3 yrs. and up	21	18
Calves born from 3-yr.-olds and up		
Alive	20	16
Dead	1	0
All calves born		
Alive	28	21
Dead	1	0
Total	29	21
Calves weaned	24	16
Percent calf crop*		
Birth	97	91**
Weaning	83	70

	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	7	82	9	82	7	78	5	74
Weaning age		223		231		217		215
Weaning weight		489		431		470		413
Adjusted weaning weight - 180 days[1]		417		354		386		366
Weaning score Conformation		79		80		82		80

*Based on cows exposed

**Two culled on basis of pregnancy test

[1]Corrected for age of dam

Montana Agricultural Experiment Station

Cow Production Data (Bozeman)--Continued Date: June 14, 1961

Breed	Angus				Angus			
Line	ROP				Show Type			
Cows bred to calve as 2-yr.-olds	3				4			
Calves born from 2-yr.-olds								
Alive	3				4			
Dead	0				0			
Cows bred to calve at 3 yrs. and up	19				10			
Calves born from 3-yr.-olds and up								
Alive	19[1]				10			
Dead	0				0			
Total	22				14			
Calves weaned	22				11			
Percent calf crop*								
Birth	100**				100			
Weaning	100				79			
	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	11	67	8	59	4	67	3	62
Weaning age		232		224		238		230
Weaning weight		466		405		462		402
Adjusted weaning weight - 180 days[2]		395		350		396		337
Weaning score								
Conformation		78		74		79		77

[1] One set twins

[2] Adjusted for age of dam

*Based on cows exposed

**One culled on basis of pregnancy test

North Montana Branch Station

Cow Production Data (Havre) Used Yearling Bull

Breed	Hereford (Polled)		Hereford		Hereford	
Line	I		II		III	
Cows bred to calve as 2-yr.-olds	7		11		6	
Calves born from 2-yr.-olds						
Alive	4		7		6	
Dead	1		0		1	
Cows bred to calve at 3 yrs. and up	19		30		13	
Alive	11		21		8	
Dead	1		0		3	
All calves born						
Alive	15		28		9	
Dead	2		0		0	
Total	17		28		9	
Calves weaned	15		26		9	
Percent calf crop*						
Birth	65.3		68.2		64.2	
Weaning	57.6		63.4		64.2	
	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.
Average:						
Birth weight	3 84	12 75	12 77	14 78	4 73	5 77
Weaning age	183	190	179	179	184	191
Weaning weight	392	388	382	398	372	404
Adjusted weaning wt. - 180 days	386	373	383	399	365	385
Weaning score Condition	65.9	71.6	71.1	75.7	66.2	74.1

*Percent calf crop calculated on basis of $\frac{\text{calves weaned}}{\text{cows exposed}}$

North Montana Branch Station

Cow Production Data (Havre)--Continued — Used Yearling Bulls

Breed	Line II, 730 Hereford	Line II, 749 Hereford	Line III, 739 Hereford
Line	Test herd	Test herd	Test herd
Cows bred to calve as 2-yr.-olds	6	6	6
Calves born from 2-yr.-olds			
Alive	2	4	6
Dead	0	1	1
Cows bred to calve at 3 yrs. and up	18	18	20
Calves born from 3-yr.-olds and up			
Alive	7	7	8
Dead	0	0	0
All calves born			
Alive	9	11	13
Dead	0	1	1
Total	9	12	14
Calves weaned	9	11	14
Percent calf crop*			
Birth	37.5	50	53.8
Weaning	37.5	45.8	50

	Steers		Heifers		Steers		Heifers		Steers		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Birth weight	5	78	4	80	7	78	4	79	6	80	8	74
Weaning age	184		165		166		181		164		184	
Weaning weight	423		383		384		386		367		441	
Adjusted weaning wt. - 180 days	417		411		395		385		393		427	
Weaning score Condition	73.1		75.9		72.3		80.0		71.6		81.2	

*Percent calf crop calculated on basis of $\frac{\text{calves weaned}}{\text{cows exposed}}$

North Montana Branch Station

Cow Production Data (Havre)--Continued — Used Yearling Bulls

Breed	Line III, 649 Hereford	M.C., 637 Hereford
Line	Test herd	Test herd
Cows bred to calve as 2-yr.-olds	6	3
Calves born from 2-yr.-olds		
Alive	6	1
Dead	0	1
Cows bred to calve at 3 yrs. and up	19	27
Calves born from 3-yr.-olds and up		
Alive		17
Dead		1
All calves born		
Alive	9	18
Dead	0	2
Total	15	20
Calves weaned	15	18
Percent calf crop*		
Birth	60	66.6
Weaning	60	60.0

	Steers		Heifers		Steers		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	8	79	7	74	9	90	9	83
Weaning age		-		182		182		184
Weaning weight		414		417		448		440
Adjusted weaning weight - 180 days		424		420		442		431
Weaning score Condition		73.8		77.1		72.3		72.6

*Percent calf crop calculated on basis of $\frac{\text{calves weaned}}{\text{cows exposed}}$

North Montana Branch Station

Cow Production Data (Havre)--Continued — Used Yearling Bulls

Breed	Polled, 714 Hereford	Polled, 717 Hereford
Line	Test herd	Test herd
Cows bred to calve as 2-yr.-olds	5	7
Calves born from 2-yr.-olds		
Alive	4	5
Dead	2	0
Cows bred to calve at 3 yrs. and up	18	16
Calves born from 3-yr.-olds and up		
Alive	11	9
Dead	0	0
All calves born		
Alive	15	14
Dead	2	0
Total	17	14
Calves weaned	15	14
Percent calf crop*		
Birth	73.9	53.8
Weaning	65.2	53.8

	Steers		Heifers		Steers		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	4	80	11	77	6	75	8	77
Weaning age		191		180		185		193
Weaning weight		450		407		423		435
Adjusted weaning weight - 180 days		429		407		415		413
Weaning score Condition		78.4		76.4		73.6		76.1

*Percent calf crop calculated on the basis of $\frac{\text{calves weaned}}{\text{cows exposed}}$

Montana Agricultural Experiment Station

Feed-lot Performance (Bozeman) Date: June 14, 1961

Breed	H	H	Angus	Angus	H	H	Angus	Angus
Line	ROP	Show Type	ROP	Show Type	ROP	Show Type	ROP	Show Type
Sex	Bulls	Bulls	Bulls	Bulls	Heifers	Heifers	Heifers	Heifers
Number on test	7	7	11	4	9	5	8	3
Average:								
Age on test	223	236	232	238	231	217	223	230
Initial weight	506	485	500	524	502	499	499	504
Initial score Conformation	79	82	79	78	80	80	77	76
Days on test	140	140	140	140	112	112	112	112
Gain per head								
Total	319	312	281	310	169	216	161	173
Av. daily gain	2.3	2.2	2.0	2.2	1.5	1.9	1.4	1.5
Efficiency of feed utilization								
#TDN/100# gain	681	666	764	732	-	-	-	-
Average:								
Final weight	825	825	782	834	671	716	660	677
Final score Conformation	77	79	75	80	78	81	76	80

North Montana Branch Station

Feed-lot Performance (Havre) Date: June 14, 1961

Breed	Hereford	Hereford	Hereford	Hereford
Line	Controls M.C. 637	Line I 714	Line I 717	Line II 730
Sex	Steers	Steers	Steers	Steers
Number on test	9	4	4	6
Average:				
Age on test	183	191	185	184
Initial weight	460	462	459	418
Days on test	196	196	196	196
Gain per head				
Total	490	518	478	503
Average daily gain	2.50	2.64	2.44	2.57
Final weight	950	980	937	921

North Montana Branch Station

Feed-lot Performance (Havre)--Continued Date: June 14, 1961

Breed	Hereford	Hereford	Hereford	Hereford
Line	Crosslines Line II 749	Line III 739	Line III 639	Pee Wee Lot
Sex	Steers	Steers	Steers	Steers
Number on test	6	6	7	10
Average:				
Age on test	165	164	174	-
Initial weight	405	385	451	333
Days on test	196	196	196	196
Gain per head				
Total	477	502	470	478
Average daily gain	2.43	2.56	2.40	2.44
Final weight	882	887	923	811

Final results will be summarized in 1961-62 W-1 Report.

Feed-lot Performance (Havre)--Continued Date: June 14, 1961

		Rancher group steers		
Breed	Hereford	Hereford	Hereford	Hereford
Line	Controls Ross × Ross	Ross × II	Davies × III	Davies × Davies
Sex	Steers	Steers	Steers	Steers
Number on test	5	6	6	6
Initial weight	438	455	396	365
Days on test	196	196	196	196
Gain per head				
Total	456	499	452	427
Average daily gain	2.33	2.54	2.31	2.18
Final weight	894	954	848	792

Ross × Ross - Bulls from Montana State College R.O.P. Line
Ross × Line II - Bull from Line II at North Montana Experiment Station
Davies × Line III - Bull from Line III at North Montana Experiment Station
Davies × Davies - Bulls from a reputation herd of Montana Registered Herefords. Final results will be summarized in 1961-62 W-1 Report.

Montana Agricultural Experiment Station

Young Animals on Feed (Bozeman) Date: June 14, 1961

	Hereford		Angus	
	Number individually fed	Number group fed	Number individually fed	Number group fed
Bulls	14		15	
Heifers		14		11
Steers		15[1]		3

[1]Crossbred

North Montana Branch Station

Young Animals on Feed (Havre) Date: June 14, 1961

	Hereford		
Purebred	Number individually fed	Number group fed	
Bulls	14		
Heifers		23	
Steers		6	
Grade			Rancher Grades
Bulls			
Heifers		60	
Steers		53	23

Montana Agricultural Experiment Station (Bozeman)

Land, Physical Facilities, and Equipment Used Date: June 14, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Beef barn and corrals	1 only	$ 18,500	60
Sheds	5 "	6,300	60
Irrigated land	200 acres	80,000	100
Saddle horses	2 only	300	60
Miscellaneous equipment	-	700	60
Total		$105,800	

Red Bluff Research Ranch, Norris, Montana

Land, Physical Facilities, and Equipment Used Date: June 14, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Houses	4 only	$ 18,000	10
Old sheds, corrals	3 "	2,000	10
New sheds	3 "	2,000	10
Deeded grazing land	9,906 A. at $12.75	124,153	10
Irrigated land	273 A. at $70.00	19,110	10
Saddle horses	1 only	150	10
Total		$165,413	

North Montana Branch Station

Land, Physical Facilities, and Equipment Used (Havre) June 14, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Bull barn	1 only	$15,750	75
Long shed	1 only	15,750	90
Home pasture	1,780 acres	25,830	90
Home farm land	200 acres	5,400	85
Leased pasture	5,000 acres	49,500	100
A. I. Truck	1 only	1,530	75
Saddle horses	8 only	720	90
Scale and weigh house (station)	1 only	1,710	90
Scale and weigh house (lease)	1 only	630	100
Corrals at home station		2,700	90
Corrals at lease		1,350	100
Cattle squeeze	2 only	360	100
Cabins at lease	2 only	1,800	100
Automatic waterers	5 only	450	90

UNIVERSITY OF NEVADA

I. Station: Nevada Agricultural Experiment Station, Reno, Nevada

II. Project Title: The effect of genetic-environmental interactions on selection responses (Project 23 W-1).

III. Personnel:

Experiment Station:
C. M. Bailey, F. H. Gilbert, and H. J. Weeth

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year and Summary of Progress and Conclusions to Date:

Performance tests were completed for rats of generations nine and ten. Matings to produce generation eleven have been made.

The incidence of sterile matings has increased, particularly in the "standard select" line. Reproductive tracts and ovary sections of both sterile and fertile female rats from the four lines are being studied in order to establish the probable nature of the sterility.

Application of Findings

When complete, results of the gain trials with rats will be useful in plotting the direction for the beef cattle investigations. To date, only portions of the rat data have been analyzed.

VI. Work Planned for the Future:

Rats of generations seven and eight were assigned at random to either the regular-line or alternate ration. These data will be analyzed.

In the event that fertility cannot be improved, a new phase of the project may be initiated. One experiment under consideration involves a comparison of methods of selection. Lines in which within-litter selection would be practiced for each of two single traits, for a combination of the two traits, and a line in which selections are made at random would be included.

VII. Publications and Manuscripts: None.

UNIVERSITY OF NEVADA

I. Station: Nevada Agricultural Experiment Station, Reno Nevada

II. Project Title: The effect of environment on selection for traits of economic importance, the value of several selection criteria, and reproduction studies in range beef cattle

III. Personnel:

Experiment Station:

C. M. Bailey, F. H. Gilbert, J. E. Hunter, C. Torell, and W. D. Foote

U. S. Department of Agriculture, Agricultural Research Service

R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

The project was continued with no change in basic procedures.

All performance-test data collected to date have been organized for analysis.

Covariance charts for estimation of inbreeding were prepared for all five lines. Inbreeding coefficients for the dams were essentially zero. Inbreeding coefficients for progeny born during 1960 averaged approximately 0.05.

Feed and feces samples were taken for calves tested during 1960-61. Digestibility coefficients will be determined.

Blood samples were drawn from calves started on test at Reno this year. These are being analyzed for serum alkaline phosphatase, blood urea, and plasma fat. Relationships of these constituents with production traits will be studied.

Bulls tested at Reno which were not retained for breeding were slaughtered. Carcass weights, grades, and 9th-12th rib-cuts were obtained. The ribs will be separated into components of fat, lean, and bone for estimation of carcass content.

Application of Findings

The significance of the work was outlined to ranchers at the Knoll Creek Field Day.

VI. Work Planned for the Future:

Performance-test data will be analyzed in cooperation with the Regional Coordinator's office. Adjustment factors for nongenetic effects and relationships among production traits will be determined.

When sufficient data are accumulated, associations between performance for the first one half of an 140-day test and for the entire test period will be evaluated.

Line bulls currently in use will be retained. Five years hence, these bulls, along with bulls in use at the future date, will be bred to random groups of nonline cows in order to obtain information relating to genetic progress.

VII. Publications and Manuscripts: None.

Cattle Inventory PROJECT SUMMARY Date: June 1, 1961
Purebred Nevada Agricultural Experiment Station

Breed	Hereford	Hereford	Hereford	Hereford	Hereford
Line	R_1 Rate of gain	R_2 Economy of gain	R_3 Conformation	K_1 Rate of gain	K_2 Economy of gain
Station	Reno	Reno	Reno	Knoll Cr.	Knoll Cr.
Bulls, 12 mos. or over	5	5	4	5	5
Cows, 2 yrs. or over	31	33	31	31	33
Heifers, yearlings	7	5	8	5	8
Bull calves	12	14	13	12	12
Heifer calves	13	12	12	13	14
Percentage used for breeding project	100	100	100	100	100
Estimated cash value	$12,900	$12,900	$12,900	$12,300	$13,800

Nevada Agricultural Experiment Station

Cow Production Data — Date: June 1, 1961

Breed	Hereford	Hereford	Hereford
Line	R_1	R_2	R_3
Cows bred to calve as 2-yr.-olds	0	0	0
Calves born from 2-yr.-olds	0	0	0
Alive	0	0	0
Dead	0	0	0
Cows bred 1959 to calve at 3 yrs. and up	30	39	29
Calves born 1960 from 3-yr.-olds and up			
Alive	22	31	24
Dead	1	1	1
All calves born			
Alive	22	31	24
Dead	1	1	1
Total	23	32	25
Calves weaned 1960	22	31	24
Percent calf crop[a]			
Birth	73	79	83
Weaning	73	79	83

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Weaning age	220		234		234		237		229		230	
Weaning weight	9	488	13	483	21	468	10	450	8	483	16	445
Weaning score												
Conformation	9	83	13	84	21	83	10	86	8	84	16	85

[a] $\frac{\text{(1) Calves born alive, or (2) calves weaned}}{\text{Cows exposed to bull}}$

Nevada Agricultural Experiment Station

Cow Production Data — Date: June 1, 1961

Breed	Hereford	Hereford				
Line	K_1	K_2				
Cows bred to calve as 2-yr.-olds	0	0				
Calves born from 2-yr.-olds						
Alive	0	0				
Dead	0	0				
Cows bred 1959 to calve at 3 yrs. and up	28	32				
Calves born 1960 from 3-yr.-olds and up						
Alive	15	26				
Dead	0	0				
All calves born						
Alive	15	26				
Dead	0	0				
Total	15	26				
Calves weaned 1960	15	26				
Percent calf crop[a]						
Birth	54	81				
Weaning	54	81				

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Weaning age	225		229		227		222					
Weaning weight	5	357	9	393	11	383	15	360				
Weaning score Conformation												

[a] $\frac{\text{(1) Calves born alive, or (2) calves weaned}}{\text{Cows exposed to bull}}$

Nevada Agricultural Experiment Station

Feed-lot Performance — Date: June 1, 1961

Breed	Hereford		Hereford		Hereford	
Line	R_1		R_2		R_3	
Sex	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
Number on test	9	13	21	10	8	16
Average:						
Age on test	239	253	253	256	248	249
Initial weight	499	468	480	446	490	432
Initial score						
Conformation	83	84	83	86	84	85
Days on test	140	140	140	140	140	140
Gain per head						
Total	338	240	305	214	314	240
Average daily gain	2.42	1.72	2.18	1.53	2.16	1.72
Efficiency of feed utilization						
Lbs. gain/100 lbs. TDN	.143	.110	.134	.106	.135	.116
Final weight	837	708	786	660	792	672
Final score						
Conformation	83	84	84	84	84	85

Feed-lot Performance--Continued — Date: June 1, 1961

Breed	Hereford		Hereford	
Line	K_1		K_2	
Sex	Bulls	Heifers	Bulls	Heifers
Number on test	5	9	11	15
Average:				
Age on test	243	247	245	240
Initial weight	362	392	389	355
Initial score				
Conformation				
Days on test	140	140	140	140
Gain per head				
Total	211	172	214	172
Average daily gain	1.51	1.23	1.53	1.23
Efficiency of feed utilization				
Lbs. gain/100 lbs. TDN	.126	.104	.120	.105
Final weight	573	564	601	522
Final score				
Conformation	83	85	84	84

Nevada Agricultural Experiment Station

Young Animals on Feed — Date: June 1, 1961

Purebred	Number individually fed		
	Reno	Knoll Creek	Total
Bulls	38	16	54
Heifers	39	24	63
Steers	0	0	0

Nevada Agricultural Experiment Station

Land, Physical Facilities, and Equipment Used — Date: June 1, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Reno station: Land, buildings, etc.	1 only	$350,000	20
Knoll Creek station	1 only	100,000	60
Laboratories	1 only	100,000	30

NEW MEXICO STATE UNIVERSITY

I. Station: New Mexico Agricultural Experiment Station, University Park, New Mexico

II. Project Title: Breeding beef cattle for southwestern ranges

III. Personnel:

Experiment Station:
L. A. Holland, J. H. Knox, and D. W. Zinn

U. S. Department of Agriculture, Agricultural Research Service,
R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Analyses of Measurements on Live Animals and Carcass Data

Least squares analyses of measurements on live animals, and carcass data from 92 steers slaughtered in 1958, 1959, and 1960, for the purpose of estimating heritabilities of traits and genetic correlations between traits was begun. The analyses were programmed for the Burroughs 220 Electronic Computer at the Physical Science Laboratory at NMSU. The necessary matrices have been inverted. Thirty sets of right-hand members have been assembled, leaving approximately 70 sets yet to be assembled. A portion of the data were analyzed to learn techniques and for use in a Master's thesis. Because slight errors have been found in computation of expectations of sums of squares and crossproducts, the estimates of heritabilities and genetic correlations obtained in the study are not reported.

The publication, "Least-Squares Analysis of Data with Unequal Subclass numbers", ARS-20-8, July 1960, by Walter R. Harvey, and the school conducted by Dr. Harvey at Stillwater last year, were quite helpful in setting up the analyses. The advice given by Dr. James S. Brinks, of the W-1 Regional Coordinator's office, concerning (1) expectations of sums of squares and crossproducts, and (2) computation of correlations between traits adjusted for the same independent variable, is greatly appreciated.

Feed Efficiency Study

Factors affecting feed efficiency of bulls fed at New Mexico State University from 1951 through 1960 were studied and the results published in a Master's thesis. The bulls were weaned at eight months of age and after an adjustment period were placed on feed for 140 days. Thus, feeding was practically on an age-constant as well as time-constant basis. Some actual means are listed in table 1. Analyses of variance for total digestible nutrients per 100 pounds of gain are reported in table 2.

Table 1.--Actual means

Classification	n	F_X (%)	Initial age (days)	Initial weight (lbs.)	Final weight (lbs.)	Daily gain (lbs.)	TDN per cwt. gain (lbs.)
Lines							
Old	42	18.9	342	680	1002	2.28	475
Outcross	23	15.4	339	675	984	2.17	482
Seasons[1]							
1	15	18.2	343	684	992	2.18	447
2	34	16.9	340	673	1010	2.37	477
3	16	18.6	341	684	968	2.03	508

[1]Season - major portion of feeding period in period
1 - February 1 through May 31
2 - June 1 through September 30
3 - October 1 through January 31

Table 2.--Analyses of variance for TDN per cwt. gain

Source of variation	Degrees of freedom	Mean squares when independent variable was		
		Inbreeding coefficient	Initial weight	Daily gain
Lines	1	793	1724	118
Years	8	13726**	1423	12135**
Seasons	2	3541	3681	3201
Regression	1	589	2212	36662**
Error	52	2551	2525	1855

Differences between lines in TDN per cwt. gain were not statistically significant in any of the analyses. Yearly differences in TDN per cwt. gain were highly significant when either inbreeding or daily gain was the independent variable, but were not significantly different when initial weight was the independent variable. Seasonal differences in feed efficiency were not significant in any of the analyses. The partial regressions of TDN per cwt. gain on inbreeding coefficient or initial weight were not significant, but the partial regression of TDN per cwt. gain on daily gain was highly significant. Regression coefficients are reported in table 5.

Analyses of variance for daily gain are reported in table 3.

Table 3.--Analyses of variance for daily gain

Source of variation	Degrees of freedom	Mean squares when independent variable was	
		Inbreeding coefficient	Initial weight
Lines	1	.27 *	.10
Years	8	.09	.11
Seasons	2	.71**	.85**
Regression	1	.24	.41**
Error	52	.06	.06

Differences in daily gain between lines were significant when inbreeding was held constant but not when weight was held constant. Yearly differences in gain were not significant. Seasonal differences in daily gain were highly significant when either inbreeding or weight was held constant. Seasonal constants for daily gain are shown in table 4.

Table 4.--Seasonal constants for daily gain

Season	Independent variable	
	Inbreeding coefficient	Initial weight
1 (Feb. 1--May 31)	-.04	-.07
2 (June 1--Sept. 30)	.20	.23
3 (Oct. 1--Jan. 31)	-.16	-.15

Differences in daily gains between seasons one and three were nonsignificant, but daily gain in season two was significantly greater than gains in the other two seasons. The greater daily gains during the summer were surprising to Dr. L. A. Holland, but were not surprising to Prof. J. H. Knox.

Partial regression coefficients with lines, years, and seasons held constant are listed in table 5.

Table 5.--Partial regression coefficients

Independent variable	Change in dependent variables associated with changes in independent variables specified in column at left			
	Initial weight (lbs.)	Final weight (lbs.)	Daily gain (lbs.)	TDN per cwt. gain (lbs.)
Inbreeding coefficient (1%)	-3.06*	-5.13*	-.014	-7.1
Initial weight (1 lb.)		1.18**	.002**	0.12
Daily gain (.1 lb.)				-10.1**

The more highly inbred individuals tended to weigh less at the start and end of the tests. Age of dam and level of inbreeding of offspring are not independent within closed lines. Since age of dam was not held constant in the analysis, an undetermined amount of the depressing effect on weight attributed to inbreeding in this analysis might be attributed to age of dam effects. The partial regressions of daily gain and TDN per cwt. gain on inbreeding coefficient were not statistically significant, but tend in the expected direction because the more highly inbred individuals made their gains in lighter weight ranges than did the less highly inbred individuals.

Heavier individuals at the start of the test tended to be heavier at the end of the test and to make larger daily gains. Initial weight and level of inbreeding were not independent; hence, part of the superiority of heavier animals in this study may be because they were less highly inbred. The partial regression of TDN per cwt. gain on initial weight was non-significant.

Animals making larger daily gains required less TDN per cwt. gain.

Hydrocephalus

Twenty-one heads of calves which were born dead or died shortly after birth were received from one ranch. Sagittal sections of the frozen heads were performed and classifications based on the area of frozen fluid were made as follows:

	Hydrocephalic				
Sex	Severe	Intermediate	Mild or slight	Normal	Total
Male	2	2	2	3	9
Female	2	2	1	7	12
Total	4	4	3	10	21

Concerned with accuracy in classifications, we appealed to the California workers to classify ten heads, using one half of each of the heads which we shipped to them frozen. The agreement between classifications made by us and the California workers was not good. Perhaps agreement would have been closer had they looked at the heads when first split as we did. We ask ourselves, "Are those we are calling mild and intermediate hydrocephalic merely 'normal variants'", and "are they the expression of the hydrocephalic gene in the heterozygous state?"

We have observed heads which we are certain are hydrocephalic but which do not have closed supra-orbital foramina which are characteristic of the extreme hydrocephalic condition segregating in one line of our experimental cattle.

Application of Findings

The performance-testing group that will begin testing bulls for rate of gain this fall at the Tucumcari substation of the New Mexico Agricultural Experiment Station will be advised to consider the relationship between initial weight and daily gain in setting up requirements for entry and in interpretation of results. A difference of 50 pounds in initial weight resulted in .1 pound difference in daily gain in favor of the heavier bulls. The group also will be advised to caution their members about comparing bulls for efficiency of feed utilization when records were made in different years.

The condition of "open supra-orbital foramina" is not diagnostic of all "kinds" of hydrocephalus. All the extremely hydrocephalic calves in the experimental herd have had closed supra-orbital foramina, but none of the extremely hydrocephalic calves from private herds observed has had closed supra-orbital foramina.

VI. Work Planned for the Future:

Data collection will be continued. Professor D. W. Zinn has resigned to accept a position with Texas Technological College. He will be replaced July 1, 1961, by Dr. Earl Ray. Dr. Ray will continue the meats investigation phases of the project. Analysis of the live animal measurements and carcass data gathered during the past three years will be completed.

The study of vaginal prolapse will be completed.

VII. Publications and Manuscripts:

Blackwell, R. L., J. H. Knox, C. E. Shelby, and R. T. Clark
1961. A genetic analysis of economic characteristics of young Hereford cattle. (Submitted to J. Anim. Sci.).

Hall, Thomas H.
1961. Factors affecting feed efficiency of Hereford bulls. M. S. Thesis. New Mexico State University Library, University Park, New Mexico

Heckman, Fred G.
1961. Genetic studies of live animal and carcass characteristics in Hereford steers. M. S. Thesis. New Mexico State University Library, University Park, New Mexico

Cattle Inventory PROJECT SUMMARY Date: June 16, 1961

Purebred New Mexico Agricultural Experiment Station

Breed	Hereford	Hereford
Line	Old Line	Outcross
Station	Main	Main
Bulls, 12 mos. or over	12	3
Cows, 2 yrs. or over	38	14
Heifers, yearlings	14	4
Bull calves	10	6
Heifer calves	11	6
Percentage used for breeding project	80	80
Estimated cash value	$25,900	$9,400

Grade

Breed	Hereford
Station	Main
Bulls, 12 mos. or over	0
Cows, 2 yrs. or over	112
Steer calves	26
Heifer calves	25
Percentage used for breeding project.	40
Estimated cash value	$25,460

Cow Production Data Date: June 16, 1961

Breed	Hereford	Hereford
Line	Old	Outcross
Cows bred to calve as 2-yr.-olds	7	3
Alive	7	2
Dead	0	1
Cows bred to calve at 3 yrs. and up	22	12
Calves born from 3-yr.-olds and up		
Alive	18	10
Dead	0	0
All calves born		
Alive	25	12
Dead	0	1
Total	25	13
Calves weaned	24	10
Percent calf crop*		
Birth	86	87
Weaning	83	67

Cow Production Data--Continued Date: June 16, 1961

	Hereford						Hereford					
	Bulls		Steers		Heifers		Bulls		Steers		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Birth weight	12	79	2	84	10	74	4	66	1	58	8	63
Weaning age	240		240		240		240		240		240	
Weaning weight	12	547	2	476	10	480	2	582	1	485	7	429
Adjusted weaning wt. - 180 days	240		240		240		240		240		240	
Weaning score												
Condition	12	10.2	2	7.0	10	8.6	2	12.5	1	11.0	7	10.4
Conformation	12	6.9	2	5.5	10	6.2	2	7.5	1	6.0	7	6.7

* Percent calf crop, birth = (number calves born)/ (Number calves bred)
Percent calf crop, weaning = (number calves weaned)/ (number calves bred)

Cow Production Data--Continued Date: June 16, 1961

Breed	Hereford
Line	Grade
Cows bred to calve as 2-yr.-olds	0
Calves born from 2-yr.-olds	0
Alive	0
Dead	0
Cows bred to calve at 3 yrs. and up	107
Calves born from 3-yr.-olds and up	
Alive	86
Dead	1
Total	87
Calves weaned	79
Percent calf crop*	
Birth	88
Weaning	

	Steers		Heifers	
	No.	Av.	No.	Av.
Average:				
Weaning weight	47	264	32	247
Adjusted weaning weight - 180 days	281		268	
Weaning score				
Conformation	47	6.36	32	6.38

*Seven cows classified as pregnant by pregnancy test in fall 1960 were shipped. If these may be counted as delivering calves, the number of calves (87 + 7 = 94) divided by number of cows bred (107) yields percent calf crop at birth - 88%. Percent calf crop at weaning not completed because the seven pregnant cows were shipped.

New Mexico Agricultural Experiment Station

Feed-lot Performance — Date: Completed test in calendar year 1960

Breed	Hereford	Hereford	
Line	Old Line	Outcross	
Sex	Bull	Bull	
Number on test	9	0	
Average:			
Age on test	326		
Initial weight	668		
Days on test	140		
Gain per head			
Total	319		
Average daily gain	2.28		
Efficiency of feed utilization, lbs. TDN/100 lbs. gain	484.25		
Final weight	987		

Young Animals on Feed — Date: June 16, 1961

	Hereford	
Purebred	Number individually fed	Number group fed
Bulls	0	0
Heifers	0	0
Steers	0	0
Grade		
Bulls	0	0
Heifers	0	30
Steers	0	30

Land, Physical Facilities, and Equipment Used — Date: June 16, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Range land	63,000 acres	$189,000	33
Farm land	52 acres	52,000	33
Feed Lots	-	30,000	50
Barns	2 only	120,000	70
Meat laboratory	1 only	100,000	10
Pathology laboratory	1 only	40,000	15
Calculators	4 only	2,800	60
Office equipment	-	600	60

OREGON STATE UNIVERSITY

I. Station: Oregon Agricultural Experiment Station, Corvallis Oregon

II. Project Title: Improvement of beef cattle through breeding methods using basic physiological differences in rate and efficiency of gains

III. Personnel:

Oregon State University:

Experiment Station:

Central Station, Corvallis:

Ralph Bogart, Leader, Hugo Krueger, Walter Kennick, Franklin Ampy, Noah England, and D. C. Church

Statistics Department:

L. D. Calvin and R. G. Petersen

Al Anglemier, Wm. Johnston, and Lloyd Westcott

Squaw Butte-Harney Range and Livestock Station, Burns:

W. A. Sawyer and Joe Wallace

Eastern Oregon Branch Station, Union:

James McArthur

Malheur Branch Station, Ontario:

E. N. Hoffman

John Jacob Astor Branch Station, Astoria:

H. B. Howell

U. S. Department of Agriculture, Agricultural Research Service:

R. T. Clark, Coordinator

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Objectives

1. The growth pattern of calves differing in rate and efficiency of gains, and according to sex, line, and year

2. The relation of nitrogenous and carbohydrate constituents of the blood and urine to rate and efficiency of gains

3. The relation of blood enzymes to rate and efficiency of gains

4. Selection for greater rate and efficiency of gains on a ration composed primarily of roughage

5. The development and use of inbred lines

6. Testing bulls of the inbred lines on commercial cows to determine their value as sires of good-doing calves

7. The inheritance of the tendency for chronic bloating

8. The interaction of inheritance and nutrition (or other environmental factors) in causing abnormalities

9. The use of physiological studies in establishing or assisting in development of reliable indices for beef cattle improvement

10. Influence of inbreeding on performance traits

11. Determine relationship between certain physiological factors and carcass value

Major Results of the Year

1. A study has been completed and manuscript prepared on the effect of inbreeding of calf and of the dam on birth weight, suckling gains, feed-test gains, and feed efficiency. Inbreeding of the calf depressed suckling gains but did not significantly influence birth weight, feed-test gains, or feed efficiency. Inbreeding of the dam did not significantly influence birth weight, suckling gains, or feed efficiency. The more highly inbred cows produced calves that showed greater feed-test gains. It was apparent that selection practiced for suckling gains (a lowly heritable trait) was not effective in preventing a depressing effect of inbreeding. The selection practiced for feed-test gains and feed efficiency (more highly heritable traits) was effective in preventing a depressing effect of inbreeding. The more highly inbred cows were more highly selected and were bred to more highly selected bulls than cows with lower levels of inbreeding and they produced calves that showed greater feed-test gains. Birth weight was not selected for directly but was selected for indirectly because of its association with rate of gain. The indirect selection prevented a depressing effect of inbreeding.

2. In cooperation with Dr. R. T. Clark and Dr. James S. Brinks, of the Regional Coordinator's office, the records for Project I have been coded and punched on IBM cards. Three different sets of cards have been punched to include the information necessary to support the following studies.

Project I--Study 1

Factors affecting feed consumption, rate of gain, and feed efficiency in cattle and the relationship among the above-mentioned traits.

The model for this study is as follows:

$$Y_{ijklm} = \mu + \text{sex} + \text{line} + \text{year} + F_x \text{ calf} + \text{error}$$

The effects of rate of gain and feed efficiency upon intake, the effects of efficiency and intake upon gain, and the effects of gain and intake upon efficiency will be determined by using path coefficients.

The regression of age at 500 lbs. on intake, gain, and efficiency for each of the four periods will be run to determine the effect of age upon these factors.

The 300-pound feed-test period has been broken into four 75-pound subperiods and each of the models given will be fitted for each period. Correlations are being determined between each period and all succeeding periods for each (1) feed consumption, (2) feed efficiency, and (3) rate of gain. The correlations also are run between each of these variables within each period and among all succeeding periods.

Study 2

A comparison of the correlations between pre- and post-weaning gains when corrected and uncorrected values are used. This study also will determine whether inbreeding depression during the suckling period is compensated for in the post-weaning period.

The model for this study is as follows:

$$Y_{ij} = \mu + \text{sex } 1 + \text{sex } 2 + \text{line } 1 + \text{line } 2 + \text{line } 3 + \text{line } 4 + \text{inbreeding dam} + \text{inbreeding calf} + \text{age of dam} + \text{year} + E$$

This model is being used for an analysis of both suckling gain and gain on test. Therefore, Y_i = suckling rate of gain per day

Y^i_j = gain per day on test

The constants obtained in this model were used and the correlations were computed.

Study 3

A determination of the time during the suckling period at which inbreeding of the calf has its most severe effect.

The model for this study is as follows:

$$Y_i = \mu + \text{sex 1} + \text{sex 2} + \text{line 1} + \text{line 2} + \text{line 3} + \text{line 4} + \text{age of dam} + \text{year} + \text{inbreeding of dam} + \text{inbreeding of calf} + E$$

Calculations have been made of the total gain in each of six 28-day periods starting with birth. Inbreeding is broken into the following discrete levels: 0-5, 6-10, 11-15, 16-20, 21-25, and > 25. The analysis will be run for each period.

Y = gain in any particular (ith) period) The analysis will be run for
i = periods 1, 2, 3, 4, 5, 6) each period.

Study 4

Correlations between gain in weight of calf and change in weight of cow for each of the six periods are being determined. This should give information on effect of weight changes in dam in any period upon amount of gain in the calf in that period and all succeeding periods.

3. Preliminary analysis of data from 1952 through 1959 by age of dam, line, and sex, for six 28-day periods from birth shows clearly that calves from 2- and 3-year-old cows gain less rapidly than those from mature dams. The Angus calves gained more and the David calves gained less than the Lionheart or Prince calves. Male calves gained about 30 pounds more in the 168-day period than the female calves (table 1). Gains were high in the first two 28-day periods, dropped during the third period, increased for the fourth and fifth periods, and were lowest in the sixth period. The lower gains in the 6th period may be due to a decline in milk production at this time, but no explanation can be offered for lower gains in the third period.

Table 1.--Suckling gains of calves for each of six 28-day periods

	Gain by 28-day periods										
Age dam	B.W.	1st	2nd	3rd	4th	5th	6th	Total	Fx Dam	Fx Calf	No.
2	61.65	41.71	39.94	42.61	45.45	43.71	40.13	315.19	8.49	13.35	31
3	65.81	45.10	43.78	42.80	46.44	49.46	40.70	333.09	7.87	14.08	54
4	64.94	50.39	54.39	46.29	61.78	64.71	41.82	384.33	6.45	13.03	51
5	65.80	51.44	50.62	46.94	47.54	49.92	40.30	352.56	4.98	11.58	50
6	69.47	51.89	50.87	48.74	48.55	44.68	40.05	354.27	4.73	12.65	38
7	72.50	54.11	55.88	48.12	55.85	48.73	46.50	381.69	.07	8.42	26
8	69.29	52.47	53.70	46.47	52.88	50.35	38.88	364.06	1.65	9.04	17
9	68.17	48.92	56.25	51.17	53.25	59.33	42.75	379.83	0.0	8.46	12
10	62.22	45.22	54.22	53.22	52.44	54.11	48.22	369.67	0.0	4.86	9
11	71.17	53.50	60.33	56.67	53.67	56.33	45.00	396.67	0.0	10.02	6
Line											
1000 1/	73.02	48.73	49.43	47.03	46.53	48.83	45.80	355.03	4.31	13.14	
0100 2/	72.73	51.22	52.38	45.78	49.26	46.42	40.53	354.11	4.29	11.57	
0001 3/	57.98	47.65	51.06	48.73	51.53	54.49	49.62	359.36	9.08	17.26	
0010 4/	65.45	50.81	45.81	40.74	43.74	46.49	37.87	328.94	3.28	7.16	
1/ Lionheart, 2/ Prince, 3/ Angus, 4/ David											
Sex											
Male	69.91	52.27	51.72	48.06	53.62	55.94	44.65	372.22			158
Female	63.09	46.50	48.79	44.26	47.82	47.10	43.48	341.53			141

4. The data on blood and serum albumen, and alpha, beta, and gamma globulins have been analyzed for the 1958 calves at each 100-pound increment from 500 to 800 pounds body weight, inclusive. Correlation coefficients of blood constituent values and production traits are presented in tables 2, 3, 4, and 5, for calves at 500; 600; 700; and 800-pound body weights, respectively. Rate of gain is related significantly to feed efficiency for all periods. Gains at the 600-, 700-, and 800-pound periods each were related closely to total gains during the feed test and to total feed efficiency. The performance at 500 pounds was not closely related to total performance. Albumen generally was inversely related to the various globulin fractions at all weight periods, and there was some negative relation of alpha with gamma globulin. There were very few significant correlations between blood constituents and production traits.

Table 2.--Correlations of blood constituents and production traits at 500 pounds body weight

	Specific gravity	Total P.S.	A.	A.G.	B.G.	G.G.	Gain for period	Efficiency period	Total gain	Total Efficiency
Specific gravity		.219	-.044	-.203	.170	.051	.137	.047	.204	.019
Total protein serum			.247	-.281	-.221	.083	.236	-.059	.082	.054
Albumin				-.388^{x}	.668^{xx}	-.487^{xx}	.189	-.133	.078	-.008
Alpha globulin					.121	-.303	.052	-.121	-.143	.112
Beta globulin						-.097	-.022	.138	-.050	-.080
Gamma globulin							-.288	.007	-.050	.010
Gain for period								-.831^{xx}	.261	-.298
Efficiency period									-.238	.391^{x}
Total gain										-.829^{xx}
Total efficiency										

Table 3.--Correlations of blood constituents and production traits at 600 pounds body weight

	Specific gravity	Total P.S.	A.	A.G.	B.G.	G.G.	Gain for period	Efficiency period	Total gain	Total efficiency
Specific gravity		.314^{x}	.205	-.220	-.334^{x}	.116	-.009	-.146	-.068	.098
Total protein serum			.202	-.333^{x}	-.186	.160	-.047	-.025	-.159	.094
Albumin				-.509^{xx}	-.607^{xx}	-.327^{x}	.085	.109	.005	-.131
Alpha globulin					.310^{x}	-.338^{x}	.199	-.103	.242	-.152
Beta globulin						-.117	-.005	-.065	.071	.133
Gamma globulin							.255	.042	-.403^{xx}	.297^{x}
Gain for period								-.638^{xx}	.701^{xx}	-.577^{xx}
Efficiency period									-.515^{xx}	.412^{xx}
Total gain										-.829^{xx}
Total efficiency										

Table 4.--Correlations of blood constituents and production traits at 700 pounds body weight

	Specific gravity	Total P.S.	A.	A.G.	B.G.	G.G.	Gain for period	Efficiency period	Total gain	Total efficienc
Specific gravity		.452^{xxx}	-.077	-.036	-.229	.246	.381^{x}	-.187	.408^{xxx}	-.326
Total protein serum			.099	-.097	-.230	.089	.066	-.034	.044	-.106
Albumin				-.106	-.648^{xxx}	-.044	-.010	.022	.015	-.060
Alpha globulin					.079	-.601^{xxx}	.078	.164	-.184	.110
Beta globulin						-.001	-.145	.220	-.216	.313^{x}
Gamma globulin							.057	-.295	.220	-.213
Gain for period								-.550^{xxx}	.425^{xxx}	-.363^{x}
Efficiency period									.485^{xxx}	.530^{xx}
Total gain										.837^{xx}
Total efficiency										

Table 5.--Correlations of blood constituents and production traits at 800 pounds body weight

	Specific gravity	Total P.S.	A.	A.G.	B.G.	G.G.	Gain for period	Efficiency period	Total gain	Total efficiency
Specific gravity		.310	.123	-.292	.168	.040	.051	-.130	-.046	-.148
Total protein serum			-.137	-.061	.282	.093	-.353^{x}	.214	-.239	.175
Albumin				-.543^{xx}	-.247	-.662^{xx}	.320	-.198	.385^{x}	-.212
Alpha globulin					-.376^{x}	-.021	-.125	.140	-.148	.135
Beta globulin						-.022	-.095	.097	-.097	-.001
Gamma globulin							-.298	.113	-.344^{x}	.188
Gain for period								-.823^{xx}	.690^{xx}	-.684^{xx}
Efficiency period									-.581^{xx}	.774^{xx}
Total gain										-.857^{xx}
Total efficiency										

4.--Continued

There were sex differences in specific gravity and alpha globulin of the blood, but when corrections were made for differences in ages of heifers and bulls, these differences in specific gravity and alpha globulin disappeared. Total serum protein at 800 pounds body weight, and gamma globulin at 600, 700, and 800 pounds body weight were significantly greater in females than in males after correction for differences in ages of males and females was made.

There were significant differences between males and females in rate of gain and feed efficiency regardless of whether a correction was made for differences in ages of the two sexes. The males gained more rapidly, even though they consumed no more feed per day than the females; consequently, they were much more efficient than the females (table 6.)

Table 6.--Values for blood constituents and production traits by sexes at each of four weights

	500		600	
	♂	♀	♂	♀
Specific gravity	1.0257	1.0261^{xx}	1.0255	1.0256
Total protein serum	6.80	7.12	6.87	6.89
Albumin	36.57	35.15	33.85	35.58
Alpha globulin	19.66	19.73	21.17	22.31^{x}
Beta globulin	16.56	18.28	17.51	17.00
Gamma globulin	27.14	26.85	26.29	25.35*
Gain for period	2.90^{x}	2.49	2.58^{x}	2.26
Efficiency period	515.96	594.84^{x}	645.7	845.5^{xx}
Total gain	2.49^{xx}	1.94	2.49^{xx}	1.94
Total efficiency	774.03	1043.0^{xx}	774.03	1043.0^{xx}
Age	228.5	249.5	271.2	293.7
Animals	26	19	26	19
Feed consumption per day	15.0	14.8	16.7	19.1
Total feed consumption	19.3	20.2	19.3	20.2

Table 6.--Values for blood constituents and production traits by sexes at each of four weights--Continued

	700		800	
	♂	♀	♂	♀
Specific gravity	1.0259	1.0257	1.0252	1.0256*
Total protein serum	6.99	6.82	7.05	6.76*
Albumin	31.12	32.73	32.24	33.24
Alpha globulin	21.36	23.46^{xx}	21.74	21.96
Beta globulin	18.16	17.86	17.31	17.54
Gamma globulin	29.70^{x}	25.91*	28.46	27.26*
Gain for period	2.51^{xx}	2.06	2.48^{xx}	1.66
Efficiency period	788.4^{xx}	1009.5	894.2	1292.4^{xx}
Total gain	2.50^{xx}	1.94	2.50^{x}	1.95
Total efficiency	777.6	1048.5^{xx}	780.2	1026.9^{xx}
Age	306.6	347.1	351.7	401.0
Animals	24	17	23	14
Feed consumption per day	19.8	20.8	22.2	21.4
Total feed consumption	19.4	19.6	19.5	21.3

5. A bloater bull was mated to eight bloater or closely related cows to obtain more information on the inheritance of the tendency to bloat. Three calves were produced from these matings; two of them are chronic bloaters while one is completely normal. Studies have been initiated on the saliva from bloater and normal animals.

6. The heritability of rate of gain and feed efficiency is being determined at the Squaw Butte-Harney station by individually feeding calves produced by dams that had been feed-tested, half of them on a high level of feeding and the other half on a ration composed largely of roughage. This study is nearing completion.

7. The three lines of Herefords and one of Angus at the Central station are being continued as closed lines. Only a few of the 1960 calves have finished the feed test, and none of the cows has calved, as of March 1, 1961. The rates of gains of the 1960 calves appear quite good. There is a shortage of bulls in the Hereford lines because of a large proportion of females, but many good Angus bulls are available for selecting replacements.

8. One bull in the Prince line sired seven out of nine calves that were abnormal (hydrocephalus.) Because of the evidence that this condition might be due to an interaction of genetics and nutrition where iodine appears to be involved in the phenotypic expression of inherited hydrocephalus, 20 Prince cows and heifers were mated to this bull and half of them have been on iodized salt, while the others have had none. The 1961 calf crop should give some information on this interaction. All other cattle have received iodized salt.

9. Bulls from each of the three Hereford lines at Corvallis and the line at Union are being tested on commercial cows by using one bull from each of the four lines each year on commercial cows at the Union station. The matings for the fourth and last calf crop in this study were made. Calves of the third crop are now under evaluation tests. Bulls by each of the four sires (about three from each) are being feed-tested. Steers by each of the four sires are being fed in lots. Gains and carcass evaluations have been obtained on the steers from the previous crop. Gains and feed efficiency determinations were made on the bulls. The heifers will be kept in the herd for evaluation of their abilities in calf production. Also, bulls from the Prince and David lines are used on commercial cows at the Astoria station.

At the Union station bulls sired by bulls of the four lines of Herefords (Lionheart, Prince, David, and Union) have been individually fed and their records are presented below.

Table 6.--Rate of gain and feed efficiency of steers according to line of sire

Line of sire	Number bulls	Suckling gains	Feed test gains	Feed per 100 lbs. gain
Lionheart	1	1.67	2.02	759
Prince	1	1.76	2.15	623
David	1	1.65	2.65	597
Union	4	1.48	2.50	567

The production data on steers sired by bulls of Lionheart, Prince, David, and Union bulls are presented in table 7. The steers sired by the Union bulls gained less during both the suckling and feed-lot periods than steers by bulls of the other three lines. There was little variation in gains during either the nursing or feed-lot periods among the calves sired by bulls of the Lionheart, Prince, and David lines, and steers were about the same in feed efficiency regardless of line of sire.

Table 7.--Production data of steers according to line of sire

Line of sire	No.	Birth weight (lbs.)	Suckling gains lbs./day	Weight on test (lbs.)	Total feed-lot gain(lbs.)	Gain per day (lbs.)	Days on feed	TDN per 100 lbs. gain
Lionheart	4	65.3	1.55	421	629	2.26	278	499
Prince	8	79.0	1.60	421	626	2.25	278	480
David	10	77.8	1.57	432	633	2.28	278	514
Union	5	72.2	1.28	347	570	2.05	278	495

Carcasses of steers sired by bulls of the four lines of Herefords (Lionheart, Prince, David, and Union) were appraised by scoring for finish, conformation, and marbling of the carcasses and by tracings of loin eye and prediction of fat content from a carcass probe. The data are presented below.

Table 8.--Carcass characteristics from steers according to line of sire

Line of sire	Carcass weight (lbs.)	Conformation score	Marbling score	Carcass grade	Loin eye area (sq.in.)	Percent fat	Loin eye area/100 lbs. carcass
Lionheart	619.3	15.7	13.0	3.0	10.7	32.3	1.73
Prince	611.8	15.6	11.1	2.0	10.3	32.0	1.68
David	630.7	15.5	11.2	2.3	10.6	32.2	1.68
Union	516.4	14.0	11.2	1.8	8.3	30.3	1.61

The primary difference between carcasses of steers sired by Union bulls and those from steers sired by bulls of the other three lines was in carcass weight (a difference of 100 pounds.) Conformation score, carcass grade, loin-eye area, and percentage of fat in the carcass also were slightly lower for steers sired by Union bulls. Steers sired by the Lionheart bull were highest in marbling score, loin-eye area, and carcass grade.

slightly lower for steers sired by Union bulls. Steers sired by the Lionheart bull were highest in marbling score, loin-eye area, and carcass grade.

The preweaning performance on all calves sired by bulls of Lionheart, Prince, David, and Union lines in 1959 is presented by sexes in table 9. Calves sired by bulls of the Union line were lowest in suckling gains, although they were not the smallest in size at birth.

Table 9.--Preweaning data on male and female calves for 1959 according to line of sire

Line of sire	Sex	Number	Birth weight (lbs.)	Suckling gains (lbs./day)
Lionheart	Male	5	65.6	1.58
	Female	9	62.0	1.49
Prince	Male	9	79.1	1.61
	Female	6	66.7	1.47
David	Male	11	70.0	1.57
	Female	7	69.7	1.52
Union	Male	11	74.7	1.35
	Female	20	73.4	1.36

The preweaning data for the calves born in 1960 are presented in table 10 by sex and line of sire.

Table 10.--Preweaning performance of calves in 1960 by Lionheart, Prince, David, and Union line sires

Line of sire	Sex	Number	Birth weight (lbs.)	Suckling gains (lbs./day)
Lionheart	Male	10	81.6	1.61
	Female	10	70.7	1.52
Prince	Male	8	76.1	1.53
	Female	7	76.7	1.62
David	Male	12	74.8	1.56
	Female	5	72.4	1.65
Union	Male	19	79.8	1.46
	Female	14	74.3	1.59

In general, the suckling gains were lower for the calves sired by bulls in the Union line than for calves sired by bulls of the other three lines. One interesting feature of these data is that females in three of the groups gained more than males during the nursing period. Since there were 29 females and 39 males in the three groups with females gaining more rapidly than males, one cannot attribute this difference to small numbers.

Heifers sired by bulls of the Lionheart, Prince, David, and Union lines are under winter feeding studies as well as being kept for evaluation of their abilities to raise calves. One group called "high" received four pounds of concentrate daily, one group called "medium" two pounds, while another called "low" received no concentrates during the winter. All three groups were given all the grass-legume hay they would eat. The suckling gains, winter gains, summer gains, and weight at 18 months of age are presented by line of sire and winter feeding level in table 11. It is of interest to note that winter gains on heifers fed at the high level were not much greater than those of heifers fed at the medium level. Also, summer gains of these groups were almost identical. Winter gains were low and summer gains were high for the heifers fed at a low level during the winter. The weight of heifers at 18 months of age was the same for the three levels of wintering.

The Lionheart heifers responded best to the low level and the poorest to high level of wintering, while the Prince and David heifers responded best to the medium and high levels of winter feeding.

Table 11.--Performance of heifers under three levels of winter feeding according to line of sire

Wintering level	Line of sire	Suckling gains (lbs./day)	Rank	Winter gains (lbs./day)	Rank	Summer gains (lbs/day)	Rank	Wt. at 18 mos. of age (lbs.)	Rank
Low	Lionheart	1.47	3	1.29	1	1.17	4	875	1
	Prince	1.58	2	1.27	2	1.24	2	840	3
	David	1.66	1	1.12	3	1.21	3	848	2
	Union	1.38	4	1.02	4	1.31	1	808	4
Average		1.46		1.12		1.26		832	
Medium	Lionheart	1.45	3	1.37	1	1.16	3	830	3
	Prince	1.58	2	1.35	2	1.18	1	900	1
	David	1.60	1	1.33	3	1.17	2	860	2
	Union	1.38	4	1.23	4	1.15	4	810	4
Average		1.45		1.29		1.16		831	
High	Lionheart	1.67	1	1.11	4	1.17	2	785	4
	Prince	1.42	4	1.44	2	1.29	1	860	2
	David	1.54	2	1.77	1	1.09	4	898	1
	Union	1.50	3	1.16	3	1.11	3	803	3
Average		1.52		1.33		1.15		830	

10. Nineteen weaned steer and heifer calves at the Squaw Butte-Harney station were fed individually a ration consisting of 50 percent native meadow hay, 34 percent rolled barley, and 16 percent cottonseed meal from February 2 to May 25, 1959. The average daily gain and feed required per pound of gain for these animals was 1.81 pounds and 7.52 pounds, respectively. These calves were progeny of heifers tested individually for their ability to gain rapidly and efficiently during the winter of 1955-56.

During an 126-day period extending from December 2, 1959, to April 7, 1960, 21 head of weaned calves (mixed sex) were fed individually the same ration used the previous winter. The average daily gain for these animals was 1.68 pounds, and feed required per pound of gain was 7.96 pounds. These animals were progeny of heifers that were feed-tested individually during the winter of 1956-57.

The data collected during these two years, along with a similar study to be conducted during the winter of 1960-61, will be used to calculate heritability estimates on rate of gain and ability to convert TDN to gain under the conditions imposed. All animals involved in these studies are progeny of the same sire and are the first calves from heifers that were feed-tested individually as weaned calves.

Final analyses on these data are awaiting the completion of the third year's work.

11. One Prince and one David bull each was used on 22 cows and heifers at the J. J. Astor station in 1959 to sire 1960 calves. The David bull settled only 50 percent of his cows while the Prince bull settled 19 out of 22 cows. The 205-day weights for the calves were:

Prince bull	349 pounds
David bull	371 pounds

The calves born from the David bull averaged 30 days later in birth date than those from the Prince bull.

VI. Work Planned for the Future:

It is planned to complete the study on alpha, beta, and gamma globulins, and specific gravity of blood serum and albumin, and to prepare the material for publication.

Blood enzymes (phosphatases, glutamic oxalacetic transaminase, glutamic pyruvic transaminase and amalyase) and cholesterol will be determined for the third year on all animals in all the lines, and data on these studies will be analyzed. This work has been done on calves at each 100 pounds increment from birth to 800 pounds body weight. Also, 12 females and 12 males in which six of each sex are top performers and six of each sex low performers in production traits are used for blood enzyme studies with

determinations made each two weeks. These data on blood will be related to production data in the analyses.

Fatty acid metabolism in relation to performance traits, and appetite will be studied from blood analyses.

In cooperation with Dr. R. T. Clark and Dr. James S. Brinks of the Regional Coordinator's office, an extensive analysis on the effects of inbreeding will be completed, and the material prepared for publication. This study is concerned with the various performance traits, the time in life when inbreeding effects are most serious, the effects of inbreeding on the relationship of traits, the ability of an animal to compensate in a succeeding period for depression from inbreeding during a previous period, a possible physiological explanation for inbreeding depression such as a reduction in feed intake associated with increased inbreeding, and the level of inbreeding at which various traits first show depression from inbreeding.

The three lines of Herefords and one line of Angus at Corvallis, and one line of Herefords at Union will be continued. Two bulls will be used in each of the four lines at Corvallis. Selection is based on an index in which suckling gains, feed-test gains, feed efficiency, and score for type and conformation are given equal weight and is used along with minimum culling levels for fertility and freedom from defects. All cattle will be weighed each week until a weight of 800 pounds is reached. All calves will be scored, measured, and photographed at 500 and at 800 pounds body weight. Cows will be culled primarily on the basis of the production and performance of their calves and they will be replaced with the best young females within the line.

The last matings have been made at the Union station in which bulls from the Lionheart, Prince, David, and Union lines are bred to cows at this station. The purebred bull calves are fed individually to obtain performance data. The other bull calves are made into steers. These steers are fed in dry lot from weaning, and when finished are slaughtered for obtaining carcass data. It is planned to analyze the data from this study covering four years of work and prepare the material for publication. The heifers produced by these matings will be put into the herd and their abilities to produce calves will be determined.

The last matings have been made to obtain calves from heifers that have been production tested at the Squaw Butte-Harney station. As soon as these calves have completed the feed test, the data will be analyzed to obtain heritability estimates for rate and efficiency of gains on a lower and on a higher level of feeding by dam-offspring regression analyses. This material will be prepared for publication as soon as the analysis is complete.

The results of the matings in which the bull in the Prince line that sired was used many calves with hydrocephalus last year will determine the value of this

line for future studies. Some evidence indicates an iodine-genetic interaction such that animals without iodized salt which inherit hydrocephalic tendencies will express the trait while those supplied iodized salt may not. If this proves to be the case with the animals in this line bred to the bull that sired hydrocephalic calves, further studies on this interaction definitely will be in order. If calves by this bull show hydrocephalus, even though the cows bearing them are given iodized salt, it will be necessary either to develop a breeding program with this line to utilize its good inheritance and eliminate the gene for hydrocephalus or to eliminate the line.

The studies on the inheritance of chronic bloating tendency will be continued.

VII. Publications and Manuscripts:

Alexander, G. I., and Ralph Bogart
1959. Effects of inbreeding on performance characteristics in inbred lines of beef cattle. (Abs.) J. Anim. Sci. 18(3):1164.

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Alexander, G. I., and Ralph Bogart
1960. Effect of inbreeding and selection on performance characteristics of beef cattle. (Submitted to J. Anim. Sci.)

Bogart, Ralph
1960. Factors affecting breeding efficiency of beef cattle. Mont. State Col. Sixth Annu. Beef Prod. Sch. Proc.

Bogart, Ralph, John Landers, Dean Frischknecht, and J. C. Miller
1960. Improvement of beef cattle through breeding. Prepared for Extension Circular.

Castle, Emery, Joe Wallace, and Ralph Bogart
1960. Optimum feeding rates for wintering weaner calves. Prepared for Technical Bulletin.

Krueger, Hugo, W. C. Van Arsdel III, and Ralph Bogart
1960. QRS and T axes in beef cattle. (Abs.) Amer. Soc. Expt. Biol. Fed. Proc. 19(1):.

MacDonald, M. A., Hugo Krueger, and Ralph Bogart
1960. Rate and efficiency of gains in beef cattle. VIII. Urinary specific gravity, pH, and buffer capacity in beef cattle. Oreg. Agr. Expt. Sta. Tech. B. 54.

Van Arsdel, W. C. III, Hugo Krueger, and Ralph Bogart
1960. Vector orientation of P, QRS, and T axes in beef cattle. Physiologist 3(3):.

Bhannasiri, Tim, Ralph Bogart, and Hugo Krueger
1961. Hemoglobin and blood cells of growing beef cattle. J. Anim. Sci. 20(1):18-21.

Cattle Inventory PROJECT SUMMARY
Purebred Oregon Agricultural Experiment Station

Breed	Hereford	Hereford	Hereford	Angus
Line	Lionheart	Prince	David	
Station	Central	Central	Central	Central
Bulls, 12 mos. or over	2	3	2	3
Cows, 2 yrs. or over	17	17	14	20
Heifers, yearlings	7	14	4	6
Bull calves	6	6	8	5
Heifer calves	9	2	6	10
Percentage used for breeding project	60	60	60	60
Estimated cash value	$18,850	$16,350	$13,800	$18,600

Grade - None.

Cow Production Data

Breed	Hereford	Hereford
Line	Lionheart	Prince
Cows bred to calve as 2-yr.-olds	7	5
Calves born from 2-yr.-olds		
Alive	2	4
Dead	0	0
Cows bred to calve at 3 yrs. and up		
Calves born from 3-yr.-olds and up		
Alive	10	18
Dead	4	1
All calves born		
Alive	12	22
Dead	4	1
Total	16	23
Calves weaned	12	4

Oregon Agricultural Experiment Station

Cow Production Data

	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	3	63	10	73	4	67	2	80
Weaning age		177		187		175		189
Weaning weight	3	405	9	375	2	293	2	331
Adjusted weaning weight - 180 days		370		344		306		322
Weaning score								
Condition	3	10.5	9	10.2	3	9	2	9.8
Conformation	3	11.8	9	11.3	3	10	2	9.8

Cow Production Data--Continued

Breed	Hereford	Angus
Line	David	
Cows bred to calve as 2-yr.-olds	1	4
Calves born from 2-yr.-olds		
Alive	0	0
Dead	0	0
Cows bred to calve at 3 yrs. and up		
Calves born from 3-yr.-olds and up		
Alive	12	10
Dead	0	0
All calves born		
Alive	12	11
Dead	0	0
Total	12	11
Calves weaned	13	21

	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	8	64	6	72	11	62	10	59
Weaning age		175		169		165		209
Weaning weight	7	346	6	347	11	395	10	374
Adjusted weaning weight - 180 days		355		361		398		359
Weaning score								
Condition	7	9.9	6	9.5	11	10.4	10	10.3
Conformation	7	10.1	6	9.5	11	11.5	10	10.9

Oregon Agricultural Experiment Station

Feed-lot Performance

Breed	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
Line	Lionheart	Lionheart	Prince	Prince	David	David
Sex	Bull	Heifer	Bull	Heifer	Bull	Heifer
Number on test	3	7	1	2	7	6
Average:						
Age on test	218	260	214	332	259	284
Initial weight	500	500	500	500	500	500
Initial score						
Condition	10.5	10.2	9	9.8	9.9	9.5
Conformation	11.8	11.3	10	9.8	10.1	9.5
Days on test	149	156	119	240	106	149
Gain						
Total	924	2093	301	300	2131	1204
Average daily gain	2.29	1.87	2.53	1.78	2.83	2.03
Efficiency of feed utilization, lbs. TDN/100 lbs. gain	740.1	909.7	715.7	890.6	679	878.02
Final weight	800	800	800	800	800	800
Final score						
Condition	11.9	11.7	11.3	11.0	10.6	11.4
Conformation	11.9	11.7	11.8	11.3	10.5	10.8

Feed-lot Performance--Continued

Breed	Angus	Angus
Sex	Bull	Heifer
Number on test	10	9
Average:		
Age on test	236	258
Initial weight	500	500
Initial score		
Condition	10.4	10.3
Conformation	11.5	10.9
Days on test	124	164
Gain		
Total	3061	2663
Average daily gain	2.46	1.86
Efficiency of feed utilization lbs.TDN/100 lbs. gain	757.0	934.3
Final weight	800	800
Final score		
Condition	11.7	11.5
Conformation	11.9	11.5

Oregon Agricultural Experiment Station

Young Animals on Feed

	Hereford (Lionheart)	Hereford (Prince)	Hereford (David)	Angus
Purebred	Number individually fed	Number individually fed	Number individually fed	Number individually fed
Bulls	3	2	7	10
Heifers	9	2	6	10

Land, Physical Facilities, and Equipment Used

Item	Number	Actual cash value	Percentage used for breeding project
Land--irrigated pasture	64 acres	$26,400	60
Dry land pasture	140 acres	42,000	60
Barns and lots	-	730	60
Squeeze chutes	2 only	750	60
Feed carts	1 only	100	100
Truck	1 only	1,400	15
Loading chute	1 only	500	25
Trailer	1 only	450	20
Portable scales	1 only		50
Miscellaneous equipment and supplies		350	25

UTAH STATE UNIVERSITY

I. Station: Utah Agricultural Experiment Station, Logan, Utah

II. Project Title: The development of breeding techniques and selection criteria for improvement of economically important characteristics in Hereford and Shorthorn cattle

III. Personnel:

Experiment Station:
James A. Bennett, and Doyle J. Matthews

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator

IV. Nature and Extent of Work Done This Year:

The development of Hereford and Shorthorn lines of cattle through a system of mild inbreeding accompanied by selection was continued according to plan. In addition, a group of some 16 dwarf carrier cows was maintained. Each year, one bull is tested on this group.

Bulls on gain tests were fed one pound of long grass hay along with the balance of the ration in a pellet again this year. This proved to be very successful. Gains averaged higher than in any previous year and bloat troubles were very minor. The pellet was made of a mixture of grains, dried beet pulp, and ground alfalfa hay, and was estimated to have a TDN content of 64 percent. Bulls that were self-fed on the pellets gained faster (2.83 pounds daily) than bulls that were tied morning and night and given all the pellets they would eat in a two-hour period (2.50 pounds daily). Difference in gain was greater during the first half of the test than during the last half. The weather was colder during the first half of the feeding period and this may have been a contributing factor. Water warmed to approximately 42° F., was available throughout the test.

Gains of Hereford bull calves during the suckling period were found to be negatively correlated ($r = -0.43$) with subsequent postweaning gains on the regular performance test. In Shorthorns, the correlation was very low and positive ($r = 0.15$).

A study to measure the influence of some environmental factors upon tenderness in beef was completed with 24 animals. These animals were all 15 to 17 months of age when slaughtered. The environmental factor studied was difference in rate of gain during the 28 days immediately prior to slaughter. Part of the animals were full fed on concentrates and gained an average of 2.85 pounds daily. The others were fed only alfalfa hay and corn silage and they averaged 1.92 pounds daily gain. Samples of the longissimus dorsi muscle were tested by the shear test in both the raw and

cooked states. The cooked meat also was scored for tenderness by a panel of eight. Shear scores on raw and cooked beef were poorly correlated. Shear score on cooked meat and the score of the panel for tenderness were highly correlated ($r = -0.88$).

Faster gains during the immediate pre-slaughter period of 28 days did not produce more tender beef than the slower gains. Considerable variation in tenderness was found among the carcasses in each group. This suggests that the individuality of the animal may make a major contribution.

A second trial involving 36 animals along a similar line has been initiated and is partially completed. Twelve of these animals have been full fed on concentrates and hay. Another group of 12 were similarly fed until 21 to 28 days prior to slaughter when they were changed to a ration of alfalfa hay alone. A third group of 12 were fed on alfalfa hay throughout. Gains of the cattle when they are full fed concentrates are expected to average about 2.8 pounds daily and those on alfalfa about 1.2 pounds daily. Cattle that are switched from a full concentrate ration to alfalfa alone are expected to gain little if any during the last 21 to 28 days prior to slaughter. The preliminary results based on one block of animals indicate that the cattle fed on alfalfa alone produced beef that was just as tender as the beef from those which gained at the higher rate.

V. Summary of Progress and Conclusions to Date:

Development of lines of Hereford and Shorthorn cattle through mild inbreeding accompanied by selection is going ahead according to plan. Weaning weight in the Herefords appears to be improving. The Shorthorns have been consistently good in this respect. Reproductive ability and carcass quality have been maintained at a high level.

Studies concerning tenderness in yearling beef suggest that fast gains during the last three or four weeks prior to slaughter do not produce more tender beef than if only moderate gains are obtained.

Work at this station has shown that tritium and NAAP (N-acetyl-4-amino antipyrene) are reasonably accurate as a basis for estimating the percentage of fat in live cattle. Biochemical analysis of body fluids also has shown promise for identification of certain genotypes in cattle. Promising leads have been found but have not been perfected.

Application of Findings

This project will provide information on the value of mild inbreeding accompanied by selection for producing productive cattle. Cattle produced by this system can be compared to cattle produced by other systems in the western region. The project has demonstrated to the cattlemen of the state

how performance testing may be conducted advantageously. Under the guidance of the extension livestock specialist, on-the-farm performance testing has been put into practice. Some 974 animals were on this type of test during the past year.

VI. Work Planned for the Future:

1. To continue development of lines of Hereford and Shorthorn cattle

2. Continue to study growth in beef cattle

3. Study influence of environment and hereditary factors upon tenderness in beef

4. Attempt to develop more accurate and simple methods of estimating body composition in live cattle and biochemical methods of estimating genotype of cattle

5. Assist extension livestock specialists in expanding the state program in performance testing

VII. Publications and Manuscripts:

Matthews, Doyle J., and James A. Bennett
1961. Tenderness of beef. Farm and Home Sci. 22(1):.

Cattle Inventory PROJECT SUMMARY Date: June 29, 1961
Purebred Utah Agricultural Experiment Station

Breed	Hereford	Hereford	Shorthorn
Line	I	II	I
Station	Panguitch	Logan	Logan
Bulls, 12 mos. or over	12	5	5
Cows, 2 yrs. or over	48	27	36
Heifers, yearlings	10	0	7
Feeders, yearlings	17	16	11
Bull calves	17	18	19
Heifer calves	24	9	16
Percentage used for breeding project	100	90	90
Estimated cash value	$25,125	$13,675	$16,325

Utah Agricultural Experiment Station

Cow Production Data — Date: June 29, 1961

Breed	Hereford	Hereford	Hereford
Line	Panguitch	Logan	Logan
Cows bred to calve as 2-yr.-olds	14	5	5
Calves born from 2-yr.-olds			
Alive	9	4	4
Dead	4	1	1
Cows bred to calve at 3 yrs. and up	41	20	25
Calves born from 3-yr.-olds and up			
Alive	40	18	23
Dead	0	2	0
All calves born			
Alive	49	22	27
Dead	4	3	1
Total	53	25	28
Calves weaned	47	21	25
Percent calf crop*			
Weaning	85	84	89

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Birth weight	26	79	21	74	11	71	10	70	10	74	15	70
Weaning age	206		205		218		223		228		226	
Weaning weight	412		382		444		414		499		452	
Adj. weaning wt. - 190 days	425		430		443		435		482		469	
Weaning score												
Condition	2.55		2.37		2.17		2.37		1.97		1.68	
Conformation	2.04		1.85		2.01		2.07		1.55		1.50	

*Based on number of cows that were alive at time of calving that had been put in the breeding herd. Cows culled for being nonpregnant are not deducted.

Utah Agricultural Experiment Station

Feed-lot Performance — Date: June 29, 1961

Breed	Hereford	Hereford	Shorthorn
Line	Panguitch	Logan	Logan
Sex	Bull	Bull	Bull
Number on test	20	1	5
Initial weight	503	688	578
Initial score			
Condition	2.41	1.7	1.68
Conformation	1.98	1.3	1.38
Efficiency of feed utilization:			
lbs. gain/100 lbs. TDN	26.2	23.9	23.6
Final weight	790	960	869
Final score			
Condition	2.24	2.0	2.34
Conformation	2.10	2.0	2.12

Young Animals on Feed — Date: June 29, 1961

Purebred	Hereford		Shorthorn	
	Number individually fed	Number group fed	Number individually fed	Number group fed
Bulls	11	10	3	2
Heifers		18		6
Steers		9		3

Land, Physical Facilities, and Equipment Used — Date: June 29, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Land - Panguitch	155 acres	$31,000	90
Land - Logan	269 acres	80,000	80
Shed, yards	5 units	60,000	90
Metabolism building	1 unit	60,000	5
Laboratory equipment, chemical		1,500	100

WASHINGTON STATE UNIVERSITY

I. Station: Washington Agricultural Experiment Station, Pullman, Washington

II. Project Title: Improvement of beef cattle by selection and mild inbreeding within lines of the Hereford, Angus, and Shorthorn breeds

III. Personnel:

Experiment Station:
C. C. O'Mary, and M. E. Ensminger

Graduate Students:
Gary Smith, Douglas Bennett, and Donald Ament

Herdsman:
W. T. Bennett

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator

IV. Nature and Extent of Work Done This Year:

A. Two methods of adjusting weaning weights of calves for age of dam were compared.

B. Time required for chaining of individual animals to self-feeders was studied further.

C. The effect of supplemental hay on gain, feed consumption, and feed efficiency was studied.

D. Additional data were obtained on feed consumption and feed efficiency within 100-pound weight increments in growing bulls and heifers.

V. Summary of Progress and Conclusions to Date:

Ninety-nine records from 27 Angus cows were used to compare two methods of adjusting calves' weaning weights for age of dam and sex of calf. Age of dam ranged from two through ten years, inclusive. Weaning weights were adjusted to 180 days of age as follows:

$$\left(\frac{\text{actual weaning weight-birth weight}}{\text{age in days}}\right) \times 180 + \text{birth weight}$$

The two methods for adjusting calves' weights for age of dam were (1) the addition of 20, 10, 5, 0, 5, and 10 percent to the weights of calves from 2, 3, 4, 5-8, 9 and 10-year-old cows, respectively, and (2) the addition of 75, 44, 19, 7, and 0 pounds to the weights of calves from 2, 3, 4, 5,

and six- to ten-year-old cows, respectively. For both methods, after adjusting for age of dam, 25 pounds was added for heifers and 15 pounds subtracted for bulls. Method (2) resulted in less within-cow variation than method (1). Correlation coefficients for weight of calf and age of dam were unadjusted, 0.93; method (1), 0.61; and method (2), -0.004. Rank of cow based on average weaning weight of calves remained essentially the same for unadjusted and adjusted weights. Both methods resulted in greater average weaning weights from 2- than from 3-year-old cows. Thus, the data suggest method (2) as the more reliable for removing variation in weaning weights due to age of dam.

The time required for chaining individual beef animals to self-feeders for determining feed efficiency is reported in the following table. The data shown are for the first two weeks of each of four years, 1957-60. After two weeks, the time of chaining remains fairly constant.

Table 1.--Time required (minutes per animal) to chain beef cattle to their individual feeders

Time		1957	1958	1959	1960	Average
No. of animals		9	22	41	38	
Day	AM or PM					
1	PM	16.67	6.23	5.66	7.89	9.11
2	AM	8.00	4.09	2.80	2.10	4.25
	PM	7.56	3.59	1.95	2.37	3.87
3	AM	7.78	2.36	1.78	2.10	3.50
	PM	7.78	3.41[1]	1.04	1.84	3.52
4	AM	4.56	1.73	1.05	1.84	2.30
	PM	4.33	1.68	0.94	1.58	2.13
5	AM	3.89	1.64	0.73	1.32	1.89
	PM	3.89	1.36	0.54	2.10	1.97
6	AM	3.00	1.82	0.51	2.10	1.86
	PM	2.78	1.59	0.62	1.84	1.71
7	AM	2.33	1.14	0.49	1.58	1.38
	PM	2.22	1.59	0.54	1.32	1.42
8	AM	2.00	0.73	0.54	1.84	1.28
	PM	1.67	1.36	0.40	0.79	1.06
9	AM	1.33	1.27	0.38	0.66	0.91
	PM	1.33	1.50	0.33	0.79	0.99
10	AM	1.00	1.14	0.38	0.66	0.80
	PM	0.89	2.04	0.38	0.66	0.99
11	AM	0.44	1.00	0.32	0.79	0.64
	PM	0.56	1.14	0.30	0.53	0.63
12	AM	0.44	0.86	0.36	0.66	0.58
	PM	0.33	1.14	0.29	0.66	0.60
13	AM	0.33	0.82	0.25	0.66	0.52
	PM	0.33	1.00	-	0.66	0.66
14	AM	0.33	0.91	0.31	0.79	0.58
	PM	0.33	0.95	0.38	0.66	0.58

[1]Different person tying for this feeding

The effect of supplemental grass hay fed with an all-pelleted ration was studied to determine its effect on average daily gain and feed consumption of calves. Nineteen animals were allowed free access to hay in addition to their twice-daily feedings of a pelleted mix containing 50 percent alfalfa hay. Nineteen animals received pellets, only. The average daily gain for animals on pellets alone was 1.67 pounds, and for those on pellets plus hay, 1.77 pounds. Analysis of variance indicated no significant differences between rations, but there was a highly significant sex difference with bulls gaining 2.12 pounds per day and heifers, 1.63 pounds. The feed consumption of calves on pellets alone was 12.99 pounds per head daily and for the other group, 11.93 pounds of pellets and 5.44 pounds of hay. The feed efficiency for calves on pellets alone was 755.5 pounds of feed per 100 pounds of gain. For calves with access to hay the feed efficiency per 100 pounds of gain was 698.4 pounds of pellets plus 323.9 pounds of hay.

Application of Findings

In making adjustments for calf weight due to age of dam, either a multiplicative or additive factor may be used without changing cow rank materially. However, the additive factor seems more effective in removing the variation in weaning weights due to age of dam.

Chaining individual animals to self-feeders for obtaining feed efficiency information appears to be a satisfactory method. With the use of pelleted feeds, the time factor is not as great as is generally presumed.

The experiment using supplemental hay for animals on an all-pelleted ration indicates that this additional feed did not result in significant additional gain but reduced feed efficiency.

Results on feed efficiency per 100 pounds of gain for various weight increments have not been analyzed.

VI. Work Planned for the Future:

The project is being revised. Future work will be carried out as outlined in the revised project, if the revision is approved.

VII. Publications and Manuscripts:

O'Mary, C. C., Douglas D. Bennett, and M. E. Ensminger
1960. Relationship of feed efficiency and rate of gain within specific 100-pound weight increments in growing beef cattle. (Abs. 21) J. Anim. Sci. 19:1224.

O'Mary, C. C.
1960. Plan permanent progress in cattle breeding. Brangus J. December, p. 10.

O'Mary, C. C.
1961. What does a herd sire have to do with weaning weights, feed-lot gains, feed efficiency, and grades of his calves? Seventh Annu. Beef Cattle Day, April 28, pp. 23-29.

O'Mary, C. C.
1961. Here's how to wean growthy, heavy calves. Natl. Livestock Producer, May, p. 17.

Cattle Inventory PROJECT SUMMARY Date: July 1, 1960
Purebred Washington Agricultural Experiment Station

Breed	Angus	Hereford	Shorthorn
Line	Eileenmere	1	1
Station	Pullman	Pullman	Pullman
Bulls, 12 mo. or over	12	7	10
Cows, 2 yrs. or over	27	22	27
Heifers, yearlings	5	5	9
Bull calves	9	8	7
Heifer calves	9	11	9
Percentage used for breeding project[1]	100	100	100
Estimated cash value	$26,000	$25,900	$24,000
Grade	None	None	None

[1]Also used for teaching

Cow Production Data 1960 Calf crop

Breed	Angus	Hereford	Shorthorn
Line	Eileenmere	1	1
Cows bred to calve as 2-yr.-olds	3	2	0
Calves born from 2-yr.-olds			
Alive	2	2	-
Dead	0	0	-
Cows bred to calve at 3 yrs. and up	22	22	24
Calves born from 3-yr.-olds and up			
Alive	20	20	21
Dead	0	0	0
All calves born			
Alive	22	22	21
Dead	0	0	0
Total	22	22	21
Calves weaned	21	22	21
Percent calf crop*			
Birth	88	92	88
Weaning	84	92	88

*$\frac{\text{No. of calves}}{\text{No. of cows exposed to bull}}$

Washington Agricultural Experiment Station

Cow Production Data--Continued Date: July 1, 1960

	Angus			Hereford			Shorthorn		
	Bull	Steer	Heifer	Bull	Steer	Heifer	Bull	Steer	Heifer
	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.	No. Av.
Average:									
Birth wt.	5 63.8	7 59.6	9 61.1	5 65.8	4 63.2	13 62.8	4 73.8	7 67.6	10 62.1
Weaning age	203	-	176	181	-	193	202	-	219
Weaning wt.	4 472	- -	9 360	5 403	- -	8 416	4 492	- -	8 468
Adj. weaning wt. 180 days	426	-	367	398	-	393	447	-	394

Feed-lot Performance Date: July 1, 1960

Breed	Angus	Hereford	Shorthorn	Angus	Heref.	Short.
Line	Eileenmere	1	1	Eileenmere	1	1
Sex	Bull	Bull	Bull	Female	Female	Female
Number on test[1]	2	2	2	5	4	4
Days on test	150	150	150	150	150	150
Gain						
Total	292.5	333.0	333.0	243.0	252.0	265.5
Av. daily gain	1.95	2.22	2.22	1.62	1.68	1.77
Efficiency of feed utilization, # TDN/100# gain	743	638	697	749	764	848

[1]Individually fed an all-pelleted ration

Young Animals on Feed Date: July 1, 1960

	Angus		Hereford		Shorthorn	
Purebred	Number individually fed	Number group fed	Number individually fed	Number group fed	Number individually fed	Number group fed
Bulls	2	2	2	3	2	2
Heifers	5	4	4	4	4	4
Steers	-	-	-	-	-	-
Grade	None	None	None	None	None	None

[1]Not fed by breed in groups

Land, Physical Facilities, and Equipment Used Date: July 1, 1960

Item	Number	Actual cash value	Percentage used for breeding project
Self-feeding silo barn	1 only	$22,000	100

UNIVERSITY OF WYOMING

I. Station: Wyoming Agricultural Experiment Station, Laramie, Wyoming, and Gillette Experiment Station, Gillette, Wyoming

II. Project Title:

W. S. 655 Criteria for improving effectiveness of selection in beef cattle

III. Personnel:

Experiment Station:
G. E. Nelms, C. O. Schoonover, P. O. Stratton, and graduate students

U. S. Department of Agriculture, Agricultural Research Service
R. T. Clark, Coordinator
J. S. Brinks

IV. and V. Nature and Extent of Work Done This Year and Summary of Progress and Conclusions to Date:

The work with freezing semen from young bulls 12 to 14 months of age is being continued. It appears that semen from the Shorthorn and Angus cattle will produce conception rates approaching that of mature bulls. However, in the use of Hereford semen, results have been poor. In the Shorthorn breed, 15 calves which are the progeny of bulls selected on the basis of carcass traits are on the ground. There are only four Hereford calves. The Shorthorn herd was inseminated only once. All Hereford cows and heifers were inseminated for two heat periods. Calves from the 1960 crop have been slaughtered; however, the carcass data are incomplete.

The data from the use of tritiated water for determining body composition have been analyzed. Apparently, something inherent in the method is unsatisfactory. The means by breeds are presented in the following table.

December	Percent body water	Percent fat	April	Percent body water	Percent fat
Angus	59.9	23.0	Angus	58.2	26.6
Hereford	51.3	38.7	Hereford	47.1	47.9
Shorthorn	33.0	75.0	Shorthorn	26.9	86.9

Within-breed correlations with gain and feed utilization were negative and nonsignificant.

The study involving measurements at birth as related to carcass measurements is being continued. Measurements have been taken at birth and on the carcass. These correlations will be determined as soon as the carcass data are complete.

The relationship between changes in cannon bone growth and changes in body weight have been investigated. The forecannon bones of 205 Hereford, Angus, and Shorthorn bull and heifer calves dropped in 1957, 1958, and 1959, were x-rayed at birth, weaning, and at approximately one year of age. The average daily gains in body weight, cannon bone length, and cannon width were studied for these periods. In both sexes, Herefords consistently weaned at lighter weights but made compensatory growth postweaning. The ratios of preweaning to postweaning gain in body weight were: bulls, H-0.70:1; A-0.87:1; S-0.76:1; heifers; H-0.83:1; A-1:1; S-1:1. Although the Angus were born with shorter, narrower cannon bones, mean changes in cannon bone length from birth to one year of age were similar between breeds within sexes. Correlation coefficients between gain in body weight, cannon bone length, and cannon widths were 0.52 or lower and generally nonsignificant.

A study involving the growth of a number of muscles is under way. It is planned to slaughter animals at monthly intervals from birth to 1,000 pounds. The muscles being studied are the longissimus dorsi, semitendenous, supraspinatus, infraspinatus, and the forearm group.

Application of Findings

Assuming that the heritability of several carcass traits is high and that individual selection is efficient for these traits, the freezing of semen and evaluating of carcasses of prospective sires before they are used, provides a method for the selection of meatier animals. The growth studies should provide information toward more intelligent selection of beef cattle.

VI. Work Planned for the Future:

To continue as outlined. In addition, some emphasis will be placed on the inheritance of growth of specific muscles, and its relation to selection for meatier animals.

VII. Publications and Manuscripts:

Nelms, G. E.
1960. Pregnancy and fertility testing cows. Cow Country, 88:7.

Combs, W., G. E. Nelms, and P. O. Stratton
1961. Changes in length and width of cannon bone as related to average daily gain in beef calves. Amer. Soc. Anim. Prod. West. Sect. Proc. Paper No. XI.

Nelms, G. E.
1961. Just what is performance testing? Univ. Wyo. Div. Anim. Sci. 2nd Annu. Beef Cattle Short Course.

Nelms, G. E.
1961. Breeding techniques in beef cattle. Cow Country. June.

Schoonover, C. O.
1961. Reproductive efficiency in beef cattle. Univ. Wyo. Div. Anim. Sci. Second Annu. Beef Cattle Short Course.

Cattle Inventory PROJECT SUMMARY
Purebred Wyoming Agricultural Experiment Station

Breed	Angus	Shorthorn	Hereford	Hereford
Line	Laramie	Laramie	Laramie	Gillette
Station	Wyoming	Wyoming	Wyoming	Wyoming
Bulls, 12 mos. or over	11	1	2	4
Cows, 2 yrs. or over	37	37	35	31
Heifers, yearlings	7	5	6	7
Bull calves	16	23	11	18
Heifer calves	15	11	19	13
Percentage used for breeding project	100	100	100	100
Estimated cash value	$13,375	$14,475	$13,550	$12,950

Cow Production Data

Breed	Shorthorn	Angus
Line	Laramie	Laramie
Cows bred to calve as 2-yr.-olds	7	7
Calves born from 2-yr.-olds		
Alive	7	5
Dead	0	0
Cows bred to calve at 3 yrs. and up	30	31
Calves born from 3-yr.-olds and up		
Alive	20	25
Dead	5	1
All calves born		
Alive	27	32
Dead	5	1
Total	32	33
Calves weaned	26	32
Percent calf crop*		
Birth*	87	87
Weaning**	70	84

Wyoming Agricultural Experiment Station

Cow Production Data--Continued

	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	13	70	11	67	20	51	7	48
Weaning age		184		181		184		208
Weaning weight	13	377	10	341	20	348	7	343
Adjusted weaning wt. - 180 days		369		338		339		304

*Live calves/number of cows in breeding pasture

**Calves weaned/number of cows in breeding pasture

Cow Production Data--Continued

Line Breed	Laramie Hereford	Gillette Hereford
Cows bred to calve as 2-yr.-olds	8	7
Calves born from 2-yr.-olds		
Alive	7	4
Dead	0	3
Cows bred to calve at 3 yrs. and up	40	29
Calves born from 3-yr.-Olds and up		
Alive	37*	23
Dead	2	3
All calves born		
Alive	44	27
Dead	2	6
Total	46	33
Calves weaned	44	27
Percent calf crop		
Birth**	96	92
Weaning***	92	75

	Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:								
Birth weight	16	75	13	69	15	75	13	70
Weaning age		183		179		192		203
Weaning weight	20	338	13	350	15	426	12	396
Adj. weaning weight - 180 days		335		352		402		359

*Includes one set of twins

**Calves/number of cows in breeding pasture

***Calves weaned/number of cows in breeding pasture

Wyoming Agricultural Experiment Station

Feed-lot Performance

Breed	Angus		Shorthorn		Hereford		Hereford	
Line	Laramie		Laramie		Laramie		Gillette	
Sex	♂	♀	♂	♀	♂	♀	♂	♀
Number on test	12	7	13	10	14	13	13	12
Average:								
Age on test	194	221	197	194	195	192	212	223
Initial weight	419	359	405	373	379	369	429	384
Days on test	168	168	168	168	168	168	168	168
Gain per head								
Total	380	314	436	345	389	345	336	246
Av. daily gain	2.26	1.87	2.60	2.05	2.32	2.05	2.00	1.46
Efficiency of feed utilization								
# feed/100# gain	702	-	690	-	641	-	-	-
Final weight	785	673	841	717	768	714	765	630

Young Animals on Feed

	Hereford		Shorthorn		Angus	
Purebred	Number individually fed	Number group fed	Number individually fed	Number group fed	Number individually fed	Number group fed
Bulls	13	14	13	0	12	0
Heifers	11	12	0	9	0	7
Steers	0	0	0	0	0	0
Grade*						
Bulls	1	0				
Heifers	0	6				
Steers	0	14*				

*Includes crossbreds

Land, Physical Facilities, and Equipment Used

Item	Number	Actual cash value	Percentage used for breeding project
Bulletin file	2 only	$ 143.90	100
Mead caterpillar	1 "	1,254.22	50
Revco semen freezer	1 "	2,650.00	80
Upright freezer	1 "	269.00	50
Hoover vacuum	1 "	25.00	30
Ditcher, Eversman	1 "	350.00	40
Calculator	1 "	500.00	25
Stainless steel water pans	6 "	130.00	30
Meat saw	1 "	613.48	50
Lease of 600 acres, 85 irrigated	6 mos.	823.98	100

U. S. RANGE LIVESTOCK EXPERIMENT STATION

I. Station: U. S. Range Livestock Experiment Station, Miles City, Montana

II. Project Titles:

APH dl-1 Rev. The development and testing of methods of measuring performance in beef cattle

APH dl-2 Rev. Development of superior lines of beef cattle

III. Personnel:

U. S. Range Livestock Experiment Station, Miles City, Montana
J. R. Quesenberry, Nat M. Kieffer, F. J. Rice, and J. J. Urick

Office of Coordinator, Denver, Colorado
R. T. Clark, Coordinator, and J. S. Brinks

IV. and V. Nature and Extent of Work Done This Year, and Summary of Progress and Conclusions to Date:

Project APH dl-1 Rev. The development and testing of methods of measuring performance in beef cattle

Feed-lot performance testing and subsequent carcass evaluation of steer progeny groups continue to receive the major emphasis in this project. Data collected at slaughter include various body form measurements, rib eye area measurements, and lean color determinations. In addition, rib samples are taken from each animal and shipped to the Meats Quality Laboratory at Beltsville for physical separation, chemical analysis, tenderness evaluation, and various organoleptic tests.

Sixty steers, representing nine different sire groups of Hereford, Charolais, Brown Swiss, and Hereford × Brown Swiss breeding were tested during 1959-60. These steers were fed for a 252-day period and were slaughtered in early July of 1960. The following table presents certain performance and carcass characteristics of these steers.

In the fall of 1960, 39 Hereford and 13 Charolais × Hereford steers were placed on postweaning gain tests. These steers are being slaughtered when each steer reaches a weight between 1000 and 1050 pounds. To date, three Hereford and three Charolais × Hereford steers have been slaughtered. Ultrasonic estimates of the depth of the fat and lean tissues at various points along the contour of the 12th rib were made on each of the 52 steers in May of 1961. The ultrasonic estimates of the amount of fat and lean tissue in the live animal will be correlated with the actual fat and lean measurements when the steers are slaughtered.

Comparison of Hereford, Charolais, Brown Swiss, and Brown Swiss × Hereford steers for certain performance and carcass traits

	Hereford (6 sire groups)	Charolais	Brown Swiss	Brown Swiss × Hereford
Number of steers	46	2[2]	3	8
Av. weaning wt. (180 days)	397	540	506	466
ADG (252-day test)	2.30	2.84	2.37	2.58
Av. final feed-lot weight	981	1274	1099	1135
Av. slaughter grade	L. Ch.	L. Ch.	H. St.	L. Good
Av. selling price/cwt.	$24.22	$24.50	$21.50	$23.00
Av. carcass grade	L. Ch.	M. Good	L. Good	H. Good
Av. percent yield	61.36	60.29	58.49	61.36
Av. composition 9-11 rib[1]				
Percent lean	42.94	47.71	49.45	48.62
Percent fat	36.80	32.92	29.08	30.43
Percent bone	19.22	18.43	20.47	20.01
Av. shear value[3]	16.47	17.43	14.78	17.17

[1]Carcass composition data on 30 Hereford steers only
[2]One Charolais steer omitted from data after post-mortem findings
[3]Low value most tender

Project APH d1-2 Rev. The development of superior lines of beef cattle

One Hereford inbred line (Line 5 - Young Mischief blood lines) was discarded in the fall of 1960 because of poor performance. Line 5 was obtained in 1946 and it was maintained as a closed line until discarded in 1960. The sex (to a heifer basis) and age of dam adjusted 180-day weaning weight of Line 5 was 372 pounds. This compares with a 411-pound average 180-day adjusted weaning weight for Line 1 over the same period of time.

Preliminary results of top-cross tests of Miles City bulls on unrelated cows owned by the Apache Tribal Enterprises, Inc., San Carlos, Arizona, are now available. The least squares means by source of sire are shown in the following table.

Source of sires	No. of sires	No. of calves	Weaning weight	Pre-weaning daily gain	Conformation score	Condition score
Line 1	3	98	455	1.61	10.6	10.2
Line 6	6	116	441	1.58	10.9	10.5
Line 9	2	116	460	1.65	10.8	10.4
Line 10	3	27	438	1.55	10.5	10.3
San Carlos	8	179	449	1.60	10.9	10.7

Individual sire effects were significant at the one percent level of probability for weaning weight and daily gain and at the five percent level for conformation score. The above data are for the period 1957-59. These tests are being continued and additional data should be available in the near future.

In 1960, 30 grade Hereford cows were selected as the foundation cattle for a group of cattle in which selection will be practiced largely for carcass traits. All of these cows were selected on the basis of their own progeny's carcass merit, or on the basis of their half-sib's carcass records. Traits considered in selecting these foundation cows were: area of rib eye, thickness of fat at the 12th rib, and tenderness as evaluated by the Warner-Bratzler shearing device. The sire used during the 1960 breeding season was selected on the basis of a sib test with the criteria of selection being for the same traits selected for in the cow herd.

In April of 1960, a cooperative study between the U. S. Range Livestock Experiment Station, the Montana Agricultural Experiment Station, and the American Breeders' Service, Chicago, Illinois, was initiated to study certain problems related to artificial breeding of beef cattle under range conditions. Among the objectives to be studied were: (a) time of occurrence of the first estrus after parturition, (b) various methods of heat detection, and (c) comparison of calving percentages between herds bred artificially and by pasture mating.

Methods of Heat Detection

Beginning April 22, a herd of 45 dry cows was observed twice daily (early morning and late afternoon) for signs of heat during a period of 33 days. In the period of observation, 42 cows exhibited signs of heat (standing to be mounted by other cows, swollen vulva, etc.) one time, 22 cows exhibited signs of heat twice, and one cow was observed to be in heat three times. The average number of days between heat periods was 18.61 days.

On June 15, artificial insemination of 88 Line 1 cows was begun. Experimental heat detection pads were glued to the median line of the backs of 55 cows at a point where the posterior edge of the pad is in line with the anterior point of the cows' hooks. The pads were of plastic construction and were approximately three inches long and one and one-half inches wide and contained a red pigment which tended to be squeezed into a canal in the center of the pad upon the exertion of sufficient pressure, as occurred when a cow was ridden by another cow.

Two yearling Holstein steers were each injected with 10 cc's of a parenteral testosterone solution containing 25 mg. of testosterone per cc. These steers were injected with the above dosage of testosterone solution at weekly intervals during the period they remained in the cow herd.

Of the 55 cows with heat detection pads, 11 pads were lost from the backs of the cows, pigment was visible in 21 pads at the first breeding of the cows, indicating that they had been ridden, and the heat pads on the remaining 23 cows contained no visible pigment at the time of first breeding although the cows exhibited other signs of heat. The performance of the Holstein steers as an aid in heat detection was only "fair". The sexual interest of these steers was quite variable although testosterone was injected at regular intervals.

The following tables summarize the artificial insemination phase of the study:

Table 1.--Breeding summary of 88 cows assigned to A. I. herd

No. cows in herd	No. cows bred	No. cows calving from A. I.	No. cows calving from clean-up bulls	No. cows dry[1]
88	88	55	9	24

[1]Includes three cows not inseminated and six cows culled in the fall of 1960 on the basis of pregnancy tests

Table 2.--Conception rate according to number of times bred

Number cows bred[1]			Number cows conceiving from		
1 time	2 times	3 times	1st service	2nd service	3rd service
79	25	3	39	15	1

[1]Does not include six cows culled in the fall of 1960 on the basis of pregnancy tests

Table 3.--Conception rate and number of services by bulls

Bull No.	No. services[1]	No. cows bred	No. cows calving	Conception rate (%)[2]	Service/ conception
560	28	28	12	42.9	2.3
637	26	21	7	30.0	3.7
793	53	47	36	76.6	1.5

[1]With exception of Bull 560, the number of services does not equal the actual number of cows bred per bull, since some cows were inseminated with semen from the same bull more than once

[2]Conception rate for a bull computed on number of cows bred to a bull as compared with the number of cows calving from that bull

The over-all conception rate was 69.6 percent. This figure is based on a total of 79 cows instead of the original 88 cows assigned to the herd. Three cows never were observed in heat and therefore never were bred. These same three cows also failed to conceive from clean-up bulls. Six cows were culled from the herd in the fall of 1960 on the basis of being classified as "open" by pregnancy test. Since several other cows in the A. I. herd that were classified "open" in the fall of 1960 by pregnancy tests (palpation) calved in the spring of 1961, it was felt that the inclusion of these six cows in the data could bias the conception rate either upwards or downwards.

The quality of the semen from the bulls used no doubt was responsible partly for the relatively low conception rates obtained. From table 3

it can be seen that only one bull settled over 50 percent of the cows to which he was bred. It can be seen also from this table that the bulls varied quite widely in number of services required per conception.

VI. Work Planned for the Future:

Inter-breed Crossing

Inter-breed crosses involving four breeds of cows and three breeds of bulls will be initiated during the 1961 breeding season and will be continued for three consecutive years. Fifty-four cows from each of the Hereford, Angus, and Charolais breeds will be assigned to the experiment initially. Thirty-six cows of the Brown Swiss breed that are available from a preliminary crossing trial also will be utilized but will not become an integral part of the program since reciprocal crosses involving Brown Swiss bulls will not be made. The Hereford, Angus, and Charolais cows will be split into nine groups of six cows each, and the Brown Swiss will be split into nine groups of four cows each. Three different bulls of the Hereford, Angus, and Charolais breeds will be used in each year of the experiment. All F_1 females will be retained to study maternal traits. Bulls of a single breed different from those breeds used in making the original crosses will be mated to the F_1 heifers.

Crossing of Inbred Lines

Reciprocal crosses involving five inbred lines of Hereford cattle will be made in each of three consecutive years starting with the 1961 breeding season. Thirty cows from each of Lines 1, 4, 6, 9, and 10 will be assigned to the experiment and six cows from each line will be mated to bulls from each of the five lines. All F_1 female progeny will be retained to study maternal traits. Hereford sires unrelated to any of the lines used in making the crosses will be mated to the F_1 females.

Data analyses evaluating the effects of selection and inbreeding in Line 1 over the past 26 years now are well under way. The study will consider both pre-weaning and post-weaning data.

Thirty additional cows will be added to the carcass herd during the 1961 breeding season. These cows will be selected on the basis of sib tests and progeny tests for the same traits taken into consideration in selecting the first group of 30 cows. Each group of 30 cows will be single sire herds and the same bull will be mated to the same cows two years in succession. These repeat matings will be an aid in evaluating environmental trends. It is planned to obtain ultrasonic estimates of fat and lean tissues on all bull calves produced within the two herds at weaning time, and repeat estimates on those bulls selected for postweaning tests at the end of the feed-lot period.

VII. Publications and Manuscripts:

Brinks, J. S., R. T. Clark, F. J. Rice, and N. M. Kieffer
1961. Adjusting birth weight, weaning weight, and preweaning gain for sex of calf in range Hereford cattle. J. Anim. Sci. 20:363-367.

Rice, F. J., R. R. Woodward, J. R. Quesenberry, and F. S. Willson
1961. Fertility of beef cattle raised under range conditions. (Submitted as Mont. Agr. Expt. Sta. B.).

Cattle Inventory PROJECT SUMMARY Date: June 1, 1961
Purebred U. S. Range Livestock Experiment Station

Breed	Hereford	Hereford	Hereford	Hereford	Hereford
Line	1	4	6	9	10
Station	U. S. Range Livestock Experiment Station				
Bulls, 12 mos. or over	16	4	3	4	4
Cows, 2 yrs. or over	195	31	30	39	35
Heifers, yearlings	46	5	8	11	9
Bull calves	58	8	8	12	10
Heifer calves	64	10	13	13	12
Percentage used for breeding project	100	100	100	100	100
Estimated cash value					

Cattle Inventory--Continued
Purebred

Breed	Hereford	Hereford	Hereford	Charolais	Brown Swiss
Line	11	12	14		
Station	U. S. Range Livestock Experiment Station				
Bulls, 12 mos. or over	4	4	2	1	0
Cows, 2 yrs. or over	41	46	49	62	39
Heifers, yearlings	8	16	7	14	6
Bull calves	13	11	22	11	11
Heifer calves	13	20	11	10	9
Percentage used for breeding project	100	100	100	100	100
Estimated cash value	$290,900 (total)				

Cattle Inventory PROJECT SUMMARY Date: June 1, 1961
Grade U. S. Range Livestock Experiment Station

Breed		Hereford	Hereford	Angus
Line		Carcass (no	line designation)	
Station		U. S. Range	Station	
Bulls, 12 mos. or over		0	0	0
Cows, 2 yrs. or over		60	109	60
Steer calves		14	49	22
Heifer calves		11	41	17
Percentage used for breeding project		100	100	100
Estimated cash value		$67,200 (total)		

Feed-lot Performance Date: June 1, 1961

Breed	Hereford	Hereford	Hereford	Hereford	Hereford
Line	1	4	6	9	10
Sex	Bull	Bull	Bull	Bull	Bull
Number on test	28	5	5	3	3
Average:					
Age on test	200.5	192.6	205.2	202.3	187.0
Initial weight	481.6	445.9	433.6	461.7	426.8
Initial score Condition	8.2	8.0	7.9	8.2	8.1
Days on test	196	196	196	196	196
Gain per head					
Total	482.9	490.2	443.0	410.0	486.7
Average daily gain	2.46	2.50	2.26	2.09	2.48
Efficiency of feed utilization, lbs. gain/ 100 lbs. TDN	21.99	21.68	21.32	19.23	23.66
Average:					
Final weight	963.6	926.4	876.6	871.7	903.8

U. S. Range Livestock Experiment Station

Feed-lot Performance--Continued

Breed	Hereford	Hereford	Hereford	Charolais	C × H
Line	11	12	14		
Sex	Bull	Bull	Bull	Bull	Bull
Number on test	11	8	5	10	1
Average:					
Age on test	199.1	200.2	193.4	199.4	157.0
Initial weight	487.9	509.9	486.2	555.6	560.0
Initial score					
Condition	8.3	8.1	8.5	8.2	8.3
Days on test	196	196	196	196	196
Gain per head					
Total	483.9	488.0	441.6	458.4	520.0
Average daily gain	2.47	2.49	2.25	2.34	2.65
Efficiency of feed utilization, lbs. gain/100 lbs. TDN	21.96	22.07	20.05	20.13	22.27
Average:					
Final weight	971.9	994.4	927.8	1012.7	1080.0

U. S. Range Livestock Experiment Station

Cow Production Data — 1960 Calf crop

Breed	Hereford	Hereford	Hereford
Line	1	4	5
Cows bred to calve as 2-yr.-olds	0	0	0
Calves born from 2-yr.-olds			
Alive			
Dead			
Cows bred to calve at 3 yrs. and up	179[1]	31[3]	21[4]
Calves born from 3-yr.-olds and up			
Alive	123	20	15
Dead	5	2	2
All calves born			
Alive	123	20	15
Dead	5	2	2
Total	128	22	17
Calves weaned	121	20	14
Percent calf crop			
Birth	76.6	84.6	89.5
Weaning	72.5	76.9	73.7

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Birth weight	60	83.3	61	78.6	13	78.0	7	73.4	8	71.6	6	75.3
Weaning age		184.4		183.3		182.7		177.0		187.4		179.5
Weaning weight	60	455.2	61	425.1	13	409.4	7	371.5	8	369.8	6	367.3
Adjusted weaning weight - 180 days		446.9		418.8		405.6		376.7		357.8		368.7
Weaning score:												
Cond. and Conf.[2]	60	79.1	61	80.2	13	76.8	7	80.6	8	70.8	6	80.2

[1]Twelve cows sold after breeding season. Percentages computed on 167 remaining cows.

[2]Weaning score takes into consideration both condition and conformation.

[3]Five cows sold after breeding season. Percentages computed on 26 remaining cows.

[4]Two cows sold after breeding season. Percentages computed on 19 remaining cows.

U. S. Range Livestock Experiment Station

Cow Production Data--Continued 1960 Calf crop

Breed	Hereford	Hereford	Hereford
Line	6	9	10
Cows bred to calve as 2-yr.-olds	0	0	0
Calves born from 2-yr.-olds			
Alive			
Dead			
Cows bred to calve at 3 yrs. and up	31[1]	44[2]	32[3]
Calves born from 3-yr.-olds and up			
Alive	21	27	21
Dead	1	2	0
All calves born			
Alive	21	27	21
Dead	1	2	0
Total	22	29	21
Calves weaned	21	25	21
Percent calf crop			
Birth	84.6	78.4	80.8
Weaning	80.8	67.5	80.8

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Birth weight	12	70.4	9	64.1	14	74.0	11	68.0	6	86.2	15	79.3
Weaning age		184.5		192.1		187.4		195.8		180.4		180.2
Weaning weight	12	407.8	9	409.0	14	407.1	11	388.2	6	425.0	15	366.8
Adjusted weaning weight - 180 days		399.8		388.1		394.4		356.0		424.6		366.4
Weaning score:												
Condition	12	77.1	9	82.1	14	74.3	11	78.5	6	80.0	15	76.1

[1] Five cows sold after breeding season. Percentages computed on 26 remaining cows.

[2] Seven cows sold after breeding season. Percentages computed on 37 remaining cows.

[3] Six cows sold after breeding season. Percentages computed on 26 remaining cows.

U. S. Range Livestock Experiment Station

Cow Production Data — 1960 Calf crop

Breed	Hereford	Hereford	Hereford
Line	11	12	14
Cows bred to calve as 2-yr.-olds	0	0	0
Calves born from 2-yr.-olds			
Alive	0	0	0
Dead	0	0	0
Cows bred to calve at 3 yrs. and up	39[1]	50[2]	31[3]
Calves born from 3-yr.-olds and up			
Alive	26	33	26
Dead	2	2	0
All calves born			
Alive	26	33	26
Dead	2	2	0
Total	28	35	26
Calves weaned	26	33	25
Percent calf crop			
Birth	77.8	77.8	92.9
Weaning	72.2	73.3	89.3

	Bulls		Heifers		Bulls		Heifers		Bulls		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	
Average:												
Birth weight	16	81.7	10	79.5	20	86.4	13	81.3	17	86.6	8	77.4
Weaning age		190.2		186.1		185.0		185.0		185.3		190.8
Weaning weight	16	476.6	10	423.0	20	465.7	13	432.9	17	444.1	8	426.5
Adjusted weaning wt. - 180 days		457.9		412.5		455.7		423.3		434.0		406.8
Weaning score:												
Condition	16	80.0	10	80.7	20	77.9	13	82.8	17	78.2	8	79.5

[1]Three cows sold after breeding season. Percentages computed on 36 remaining cows.

[2]Five cows sold after breeding season. Percentages computed on 45 remaining cows.

[3]Three cows sold after breeding season. Percentages computed on 28 remaining cows.

U. S. Range Livestock Experiment Station

Cow Production Data--Continued 1960 Calf Crop

Breed	Hereford		Charolais[2]		Brown Swiss	
Line	Grade					
Cows bred to calve as 2-yr.-olds	0					
Calves born from 2-yr.-olds						
Alive						
Dead						
Cows bred to calve at 3 yrs. and up	214[1]		53[3]		17[4]	
Calves born from 3-yr.-olds and up						
Alive	147		40		11	
Dead	8		2		1	
All calves born						
Alive	147		40		11	
Dead	8		2		1	
Total	55		42		12	
Calves weaned	144		39		11	
Percent calf crop						
Birth	84.2		87.5		75.0	
Weaning	78.3		81.2		68.7	

	Steers		Heifers		Bulls		Heifers		Steers		Heifers	
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.
Average:												
Birth weight	84	89.2	60	80.5	17	92.1	22	82.1	3	89.	8	85.0
Weaning age		184.3		192.7		187.1		186.2		177.7		190.6
Weaning weight	84	442.3	60	426.0	17	548.7	22	477.7	3	500.7	8	519.3
Adjusted weaning wt. - 180 days		434.1		402.7		531.3		463.7		506.6		495.4
Weaning score Condition	84	81.7	60	80.7	17	82.1	22	81.0	3	77.7	8	78.7

[1]Thirty cows sold after breeding season. Percentages computed on 184 remaining cows.

[2]Includes Charolais and Charolais × Hereford crossbreds.

[3]Five cows sold after breeding season. Percentages computed on 48 remaining cows.

[4]One cow sold after breeding season. Percentages computed on remaining 16 cows.

U. S. Range Livestock Experiment Station

Young Animals on Feed — Date: June 1, 1961

Purebred	Hereford Number individually fed	Charolais Number individually fed	Charolais × Hereford Number individually fed
Bulls	68	10	1
Heifers			
Steers			
Grade			
Bulls			
Heifers			
Steers	39		13

Land, Physical Facilities, and Equipment Used — Date: June 1, 1961

Item	Number	Actual cash value	Percentage used for breeding project
Land	56,000 acres	$ 812,500	92
Buildings, corrals, land improvements, fence, and residences, etc.		2,500,000	92

Discussions

Arizona

Dr. Pahnish discussed the importance of interactions in the San Carlos data and pointed out that year and age-of-dam subclasses having higher means consistently showed greater sex differences than those with lower means. He discussed the multiple range test used to evaluate individual sires (see supplement in report). The solid line encompasses all sires for which there were no significant differences in the mean weaning weights or scores of the progeny. Only in the case of Line 1 were there significant differences among sires of the same Miles City line for weaning weight. There were significant differences among sires produced in the San Carlos herd.

California

Dr. Rollins discussed project 1216 which has been completed. Selection of bulls fed a primarily roughage ration for four months postweaning was effective as measured by weight for age of the steer progeny. The Brahman × Hereford experiment also has been completed. Results from the six-year experiment showed Herefords to have a greater feed capacity than Hereford × Brahman crossbreds. Herefords gained more and were more efficient during cool weather but gained significantly less during the heat of summer. Analyses are planned for data accumulated on the Rover line.

Colorado

Dr. Stonaker discussed the progeny testing work using bulls from Colorado lines at other stations. He pointed out that the way the bulls are ranked at home on gaining ability has been associated with the way they are ranked elsewhere. The study on blood antigens as related to performance has been completed. Semen morphology seems to be adversely related to inbreeding.

Hawaii

Dr. Cobb reported that the Hawaii station is emphasizing carcass studies and discussed the results to date. He pointed out that they are taking specific gravity of the whole carcass by immersion. The method is quick, easy to use, and does not affect the meat.

Idaho

Dr. Christian discussed the study of semen production in young bulls. Unsatisfactory results were obtained using the small ram probe on the electro-ejaculator, and a new one of intermediate size has been designed

and will be used next year. He commented that the State production testing program is well under way and considerable data will be available in the near future.

Montana

Professor Willson discussed the cooperative work with the Montana Hereford and Montana Angus Associations concerning the progeny comparison of Show Type and Record of Performance bulls. The work will be discontinued this year.

Mr. Windecker discussed the work being done at the North Montana Branch Station, Havre. Comparisons of rancher steers and station crossline steers fed at the station show about 15 percent advantage in gaining ability for the station steers. Topcrossing station bulls with industry cattle showed about ten percent advantage in gain over progeny of rancher bulls.

Nevada

Dr. Bailey discussed the genetic-environmental interaction study being carried out at the Reno and Knoll Creek stations. Analyses have begun on the first five years' data with the objective of obtaining adjustment factors. Next year, two sires per line probably will be used instead of one.

New Mexico

Dr. Holland stated that a study on feed efficiency of bulls had been completed. Bulls made greater daily gains during the hot summer months. He commented on the hydrocephalous condition present in both station and rancher cattle. In the experimental cattle, the hydrocephalic calves have closed supra-orbital foramena without exception, whereas in rancher cattle the foramina were all normal. Work is being continued to determine what is "normal" as compared to varying degrees of hydrocephalus. Dr. Holland stated that a bull testing station is being set up at the Tucumcari substation.

Oregon

Dr. Bogart discussed the inbreeding study just completed. Inbreeding of calf decreased suckling gains but did not decrease postweaning gains. Inbreeding of dam did not decrease any of the traits, and there was a significantly higher feed efficiency among the calves from more highly inbred dams. The physiology studies show that there are relationships among the specific gravity of the different protein fractions, total protein, and alpha, beta, and gamma globulins. None appear to be good indicators for predicting future performance of gain or efficiency.

Utah

Dr. Bennett reported on methods of performance testing where comparisons were made between bulls that were self-fed and those hand-fed twice daily. Self-fed bulls gained 2.83 pounds per day compared with 2.50 pounds for those hand-fed on a pelleted ration supplemented with one pound of long hay. Continued emphasis is being placed on carcass studies.

Washington

Dr. O'Mary discussed performance testing procedures used at the Washington station. Information is being collected on an age-, time-, and weight-constant basis.

Wyoming

Dr. Nelms reported on the results of freezing semen from young bulls and slaughtering them for carcass evaluation. He expressed hope of initiating a study where calves would be slaughtered, some at birth and some at monthly intervals, in order to get a picture of muscle growth. He discussed also his work on estrus synchronization using a synthetic progesterone compound developed by Upjohn. It is active both orally and by intramuscular injections. Results to date are very promising.

U. S. Range Livestock Experiment Station

Dr. Kieffer discussed this year's results of the steer performance testing project. Thirty-nine Hereford and 13 Hereford × Charolais were slaughtered locally at a constant weight of 1,000 to 1,050 pounds. Separation of fat, lean, and bone of the 9-10-11 rib-cut was done at Miles City. Faster-gaining steers tended to have more lean and bone and less fat. He commented that the Line 1 selection study concerning 26 years of inbreeding and selection is approaching completion.

Business Meeting

The business meeting was called to order by the acting chairman, Dr. N. M. Kieffer, at 8:10 p.m., July 20.

The first order of business was project revisions. A discussion ensued concerning revisions not yet circulated among committee members but which will be initiated prior to the next annual meeting.

Dr. Bennett made the motion that in cases where project revisions will be initiated prior to the next annual meeting, the project leader circulate the revision to the various technical committee members, so that their comments on the project revision along with their acceptance or disapproval may be sent to the Chairman for the coming year, the Chairman to send the comments on to the project leader.

Dr. Bogart seconded the motion.

Motion carried.

Professor Willson stated the need for circulating project revisions among the technical committeemen prior to the annual meeting so as to take advantage of the greater opportunity for discussion at the meeting.

Dr. Burris stated that Dr. Rasmussen had a good point when he asked whether a project is regional or local. The basis for evaluation should be, "Will it be an effective tool for the regional project, and, how well does it fit in with the aim of the whole project?"

Dr. Wheeler stressed that revisions should be circulated prior to the annual meetings so the committee can be prepared to discuss them.

Dr. Cobb agreed that it would be desirable to have the proposed revisions circulated before the date of the meeting, thus giving each committeeman the opportunity to submit his comments.

Dr. Brinks stated that it may be desirable to include a section in the revision on the proposed method of analysis as an aid to committeemen reviewing the project.

Dr. Warwick suggested that in order to get projects correlated on a regional basis, the technical committee should handle them as a group, accepting those in research areas which they feel are the most critical, and using some persuasion to get projects initiated in fields where work needs to be done.

Dr. Wheeler stated that there is a necessity for real agreement in the light of changing trends on the direction W-1 should be taking, and that there comes a time for re-evaluation of objectives and placing of emphasis. He suggested a subcommittee be appointed to look at W-1 objectives and that this be a topic discussion in 1962.

Dr. Bogart agreed and recommended that a subcommittee of technical committee members called "Objectives Study Committee" be appointed.

Dr. Kieffer called for discussions on project revisions by stations.

Arizona

Dr. Pahnish said he hopes to revise his project before the 1962 breeding season. The direction of the revision will depend upon analysis of data already accumulated. He would like to make a more critical evaluation of Miles City lines. Female progeny produced under the present project would be evaluated, and there is a possibility of forming two to three

sire lines from the better-performing male and female progeny.
The people on the reservation have indicated an interest in doing progeny testing with bulls from outside sources. Dr. Pahnish thinks they would be willing to test other inbred lines developed in the Western Region if they could be sure the stock was free of dwarfism and other abnormalities.

California

Dr. Rollins stated that the present State Project 1216 will be concluded next year when the last experimental calf crop is weaned. One phase will need to be analyzed.

Dr. Rollins outlined his proposed project revision involving a crossbreeding experiment with the three British breeds.

Ninety-six weaner heifers--32 from each of the Angus, Hereford, and Shorthorn breeds--were purchased during the summer of 1961. They ranged in age from 6 to 13 months at time of purchase. In an attempt to get a representative sample from each breed, the rule was established that no more than six heifers should come from any one blood line, and no more than three by any one sire. No inbred calves were used. All calves graded 2- or higher.

It is planned to use artificial insemination throughout the experiment. The heifers will be bred three seasons at Davis, starting in January 1963. The matings will be as follows, the lower right-hand corner showing the genotypes of the resulting calves:

Breeding season	Bulls	Cows		
		A	H	S
1963	2 Angus	AA	AH	AS
1964	2 Hereford	HA	HH	HS
1965	2 Shorthorn	SA	SH	SS

Our main comparison is of the type:

$$\Delta = \overline{AA} + \overline{HH} - (\overline{HA} + \overline{AH})$$

This difference will be calculated for a single bull of each breed involved, the pairs of bulls thus providing two replicates. Bull bias will be eliminated as far as additive gene action is concerned, since each bull will be contributing to the straightbred and crossbred average. In regard to nonadditive gene action, especially of an epistatic nature, one may raise the question of whether the two bulls from each breed are sufficiently representative in the sense of nicking within their own breed or contrariwise with another breed. Using two bulls per breed rather than one will help in this case. The question of bull-year interaction

also might be raised in a somewhat similar manner since two years enter into the comparisons. It should be noted, of course, that straightbred and crossbred components both occur in each of the two years. If some bias is introduced from the two sources just discussed, this will tend to be averaged out when we compare the results of our experiment with those conducted elsewhere. We are loath to increase the number of bulls because we plan to split the progeny into various treatment groups (of a factorial nature) after weaning, and wish to maintain adequate within-group numbers.

Upon being weaned the steers will be individually fed a high concentrate ration until about in choice condition. Half of them will receive stilbestrol.

At weaning, half of the heifers will be sent to the Sierra Foothill Range. There they will be grown out under range conditions until they are two-year-olds at which time they will be bred. The remaining half will spend a year at Davis on a high plane of nutrition and then will be sent to the range, and thenceforth treated similarly to their mates that were sent there earlier.

The matings at the range will commence in January 1966, and have the following design:

Breeding season	Bulls*	Calves produced		
1966	2 Angus	AX(AXA)	AX(AXH)	AX(AXS)
1967	2 Hereford	HX(HXA)	HX(HXH)	HX(HXS)
1968	2 Shorthorn	SX(SXA)	SX(SXH)	SX(SXS)

*Not the bulls used at Davis

Each heifer will raise one calf which will be individually fed and studied through the carcass stage.

Probable duration: Eight years (1963 to 1970, inclusive).

Dr. Rollins indicated that he will circulate the project revision prior to next year's meeting, and although he will be on sabbatical there will be someone from the California station present.

Colorado

Dr. Stonaker stated Colorado has no revised project planned. However, a project is in the mill which is logical for W-1, but there is no financing for it as the other work cannot be dropped. The project would deal with the heritability of the chemical constituents of beef.

Hawaii

Dr. Cobb stated that there are no project revision plans at this time.

Idaho

Dr. Christian indicated that Idaho will be revising the project in the coming year. Performance tested bulls will be placed in cooperator's herds to obtain progeny information. The project revision will be circulated as soon as possible before January 1, 1962, so it can be discussed at the next annual meeting.

Montana

Professor Willson indicated they would like to look at the project within another year. Professor Flower is presently analyzing data on the recurrent selection experiment.

Nevada

Dr. Bailey stated that the genotype-environmental interaction study with rats has proceeded through generation 9. It appears that one of the four lines, the SS (selected line on high nutritional plane), will be lost because of poor fertility. The fertility problem possibly will make it impossible to continue under the present outline and they would like to consider a revision based on the accumulated information. He outlined a 2×3 factorial genotype-environmental interaction experiment in which rats will be selected at random and for gain or final weight under three nutritional regimes. Intra-litter selection will be used since it more closely approximates selection in cattle and rate of increase of inbreeding will be slower. In addition, second litters will be used to determine carcass composition to ascertain whether selection under the different nutrition levels leads to differences in muscle, fat, and bone content. A project outline will be circulated to technical committee members prior to the next annual meeting.

Oregon

Dr. Bogart stated that the Oregon station probably will want to make a revision within a year. The revision contemplated will involve combining the three Hereford lines and using Miles City Line 1 and Lionheart bulls to form a new synthetic line. Inbred calves from noninbred dams, noninbred calves from inbred cows, etc., can be compared. A revision will be circulated prior to the next W-1 meeting if the revision seems advisable.

Utah

Dr. Bennett stated that Utah planned no revision.

Washington

Dr. O'Mary commented on the Washington station's revision that was circulated to and accepted by the technical committee members. The calves will be weaned at approximately 190 days of age and put on test on a time constant basis about two weeks later. Information will be collected on a time-, age-, and weight-constant basis. Intentions are to slaughter calves at a constant weight of 1,000 pounds. He stated that the suggestions by committee members were of great help.

Wyoming

Dr. Nelms indicated that no revision is planned.

U. S. Range Station

Dr. Kieffer called on Dr. Warwick to present the U. S. Range Livestock Experiment Station crossbreeding project.

Phase I. Fifty-four cows from each of the Hereford, Angus, and Charolais breeds will be assigned to the experiment initially. Thirty-six cows of the Brown Swiss breed that are available from a preliminary crossing trial also will be utilized but will not become an integral part of the program since reciprocal crosses involving Brown Swiss bulls will not be made. The Hereford, Angus, and Charolais cows will be split into nine groups of six cows each, and the Brown Swiss will be split into nine groups of four cows each. The plan of matings is presented below.

	Breed of Dam			
Breed of bull	Hereford	Charolais	Angus	Brown Swiss
Hereford				
1	6	6	6	4
2	6	6	6	4
3	6	6	6	4
Charolais				
1	6	6	6	4
2	6	6	6	4
3	6	6	6	4
Angus				
1	6	6	6	4
2	6	6	6	4
3	6	6	6	4

Each group of six cows in each breed will be made as nearly comparable as possible for age, producing ability, and genetic background. Cows will not be removed from the experiment for reasons other than for disease and accidental injuries. Each breeding herd of 22 cows will be mated to a different breed of bull in each year the experiment is in progress. Three different bulls of the Hereford, Angus, and Charolais breeds will be used in each year of the experiment, and each bull of the same breed will be obtained from a different herd in all years of the experiment. No attempt will be made to use performance-tested bulls to the exclusion of nonperformance-tested bulls, and no Hereford bulls produced at the U. S. Range Livestock Experiment Station will be used. Birth weights, weaning weights, and weaning scores will be obtained according to past procedures. Two bull calves selected at random from each breed cross (total of 18 per year) involving Hereford, Angus, and Charolais cows will be retained intact and grown out in a group for physiological studies of breeding soundness. The ejaculate of each will be collected periodically to determine age at onset of puberty, sperm concentration, sperm morphology, sperm vigor, and percentage of live sperm. One bull from each breed cross (total of three per year) involving Brown Swiss cows will be retained for the same purpose as above. The remainder of the males will be castrated and tested for their postweaning gaining ability and carcass desirability.

Phase II. All F_1 females will be retained to study maternal traits. Bulls of a single breed different from those breeds used in making the original crosses will be mated to the F_1 heifers. This phase of the experiment will be continued until the youngest group of F_1 heifers has produced at least one calf crop.

Probable duration: Six years.

Dr. Kieffer stated that the project outline will be circulated among the committee members within a month.

Dr. Warwick presented the proposed cooperative study of genetic-environmental interaction at Miles City, Montana, and Brooksville, Florida.

Two groups of breeding cattle will be established at each of the two locations in the study with each group being initially genetically similar to one of the groups at the other location. One pair of herds will be established by subdivision of the present Miles City Line 1 herd. This line has been bred under range conditions as a closed herd at Miles City for over 25 years and, if adaptation is a factor, should be adapted to that area. Inbreeding averages about 20 percent, so genetic variability still should be ample for divergence if a tendency for this is a factor at a second location.

At each location, 80 cows of Miles City Line 1 origin will be assigned to a group to be bred as a closed line at that location. Selection in each

closed line will be for the same traits for a period of several generations. Also, at each location 20 cows equivalent genetically to those going into the closed herd will be put in a "control" herd in which they and their female descendants will be bred to bulls from the closed line at the other location.

Thus, side by side, and maintained under the same management at each location, will be a herd selected for performance at that location, and one which in effect has been selected for performance at the other. Comparisons of the performance of the two herds will be used as a measure of whether adaptation to a specific environment is an important factor in selection within a British beef breed.

The second population of 50 cows at each of the two locations will be established by subdividing the present Hereford herd at the Brooksville station (plus additional animals purchased in the area as needed for sake of numbers) and sending half to Miles City, Montana. The present Brooksville, Florida, Hereford herd contains animals descending from a variety of foundation stocks assembled in the last seven or eight years. Most of the animals are first- or second-generation cattle raised and selected under Florida conditions. It will be augmented by the purchase of heifer calves from breeders in the General Florida-South Georgia area as necessary to build up a herd of 100 females.

At each location a closed herd will be maintained thereafter with selection according to the same criteria as in the Line 1 cattle described above. No sublines of these two lines will be maintained at the other station since it is believed that comparisons of the two groups under selection as closed lines at each location, together with the comparative performance of the Miles City Line 1 and its subline bred by bulls from the other location, will provide adequate basis upon which to judge the degree of differentiation into types unique for each location. At some future date it may be desirable also to make exchanges of breeding stock between the two stations in this line in order to provide for direct comparisons.

Dr. Warwick stated that the outline would be circulated promptly and that comments and criticisms would be welcomed.

The next order of business was the selection of a meeting place for next year. Dr. Kieffer reminded the committee that Utah had yielded to Stillwater, Oklahoma, in 1960 for the joint meeting and again in 1961 to Pullman, Washington, because of proximity to the Western Section meetings held in Moscow, Idaho.

Dr. Stonaker commented that Utah should yield again, and invited the committee to Fort Collins since the Western Section meetings will be held in Laramie, Wyoming.

Dr. Bennett extended an invitation to meet at Logan, Utah.

Dr. Bogart commented that if the Oregon station is fortunate enough to have the national American Society of Animal Production meetings in Corvallis in 1963, Utah would be the most centrally located place for the W-1 meetings that year.

Dr. Cobb moved that the committee meet at Fort Collins, Colorado, next year. Dr. Stonaker seconded the motion. Motion carried.

Dr. Bennett moved that if the Western Section meeting is held July 15, the W-1 meeting be held prior to that date, but if the Western Section meeting is held July 8, the W-1 meeting be held after July 8. Dr. Bogart seconded the motion. Motion carried.

Dr. Bogart moved that the next W-1 Technical Committee Chairman, since he is the one who will work with the committee for reviewing objectives, appoint a subcommittee to make a study and evaluation of our aims and objectives in the project. Dr. Cobb seconded the motion. Motion carried.

Professor Willson moved that Dr. O'Mary's position as the next Chairman of the W-1 Technical Committee be confirmed. Dr. Bennett seconded the motion. Motion carried.

Dr. Christian then presented the Resolutions Committee report.

> BE IT RESOLVED, That the W-1 Technical Committee express appreciation to Washington State University for the accommodations provided, and particularly to the Animal Science staff for the careful planning of the program, for the barbecue for committee members and their families, and for the pleasant time enjoyed at Washington State University.
>
> BE IT RESOLVED, That the W-1 Technical Committee express to Dr. R. T. Clark, Regional Coordinator, regret that due to illness he was unable to attend the annual meeting, and gratification that he is making a satisfactory recovery and soon will resume his duties.

Dr. Christian moved the acceptance of these resolutions. Dr. Bogart seconded the motion. Motion carried.

Dr. Burris stated that presently there are two bills before the House of Representatives concerning proposed legislation on humane treatment of laboratory animals. Also, the Standardization Branch has sent out notification that they will be glad to give any assistance in the grading of these animals that is desired.

Dr. Burris said that at the time state projects are to be reviewed, a short summary of each project will be available from the State Experiment Stations Division.

Dr. Warwick stated that so far as the U. S. Department of Agriculture is concerned there are no increases in the operating budget.

He suggested that in regard to the semen bank proposal, it might be in order for the Technical Committee again to make an expression on the subject.

Dr. Warwick also stated that in a recent meeting at Fort Collins it was unanimously agreed there was need for work in relating live animal characteristics to carcass characteristics.

Dr. Wheeler stated that in regard to regional allotment to W-1, there is a possibility there may be an adjustment in the total allotment to the restoration level which the W-1 Technical Committee recommended last year, when funds are available to make it possible. With reference to state allotments, it always has been the privilege of the committee to review the state allotments and make recommendations to the administrative adviser. Otherwise, it can be assumed that the 1961-62 state allotments will be the same as last year.

Dr. Brinks said that Dr. Clark wished to express his regret at not being able to attend the meeting this year and to thank the members of the group for their cards and letters.

The meeting adjourned.